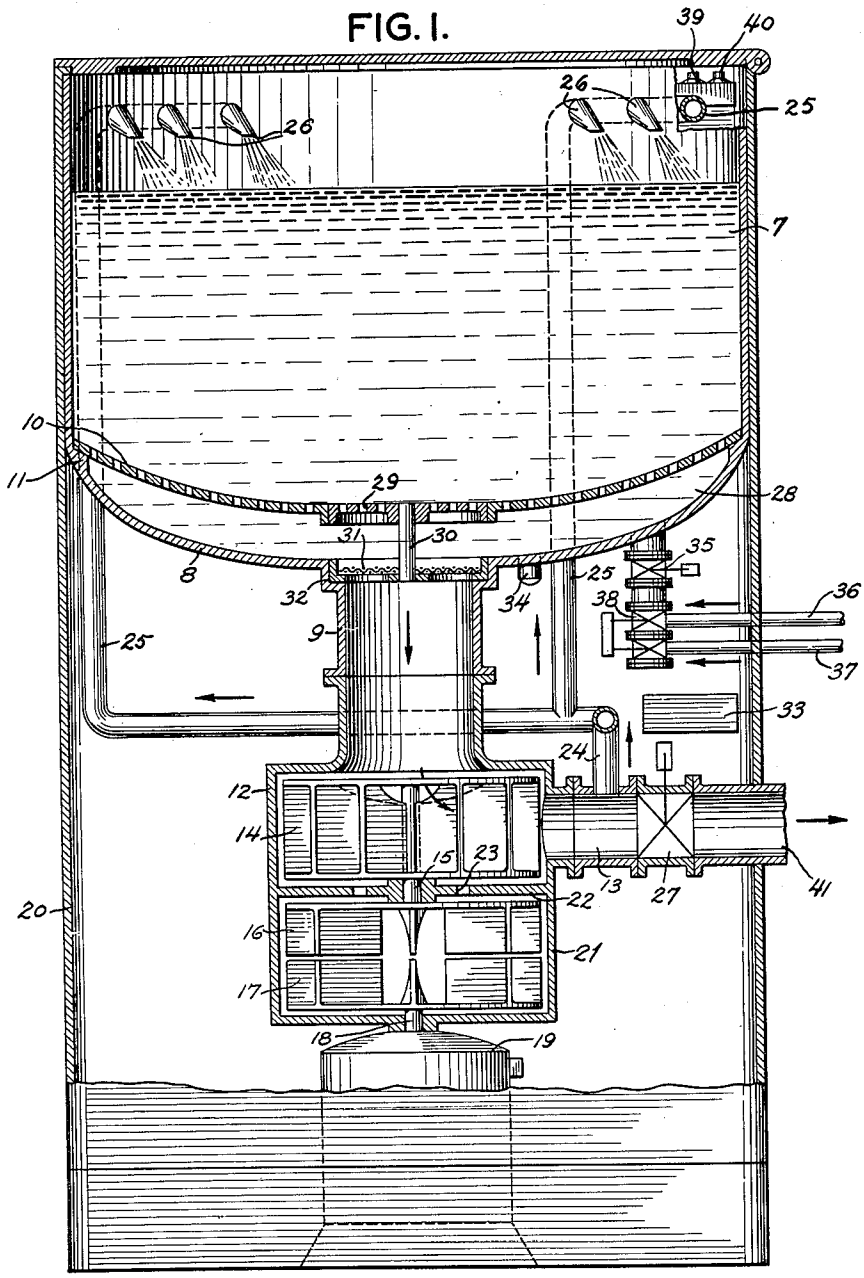
April 21, 1953 E. M. VAN DORNICK 2,635,447

WASHING MACHINE

Filed April 29, 1948 5 Sheets-Sheet 1

FIG. 1.



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WASHING MACHINE

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FIG. 2.

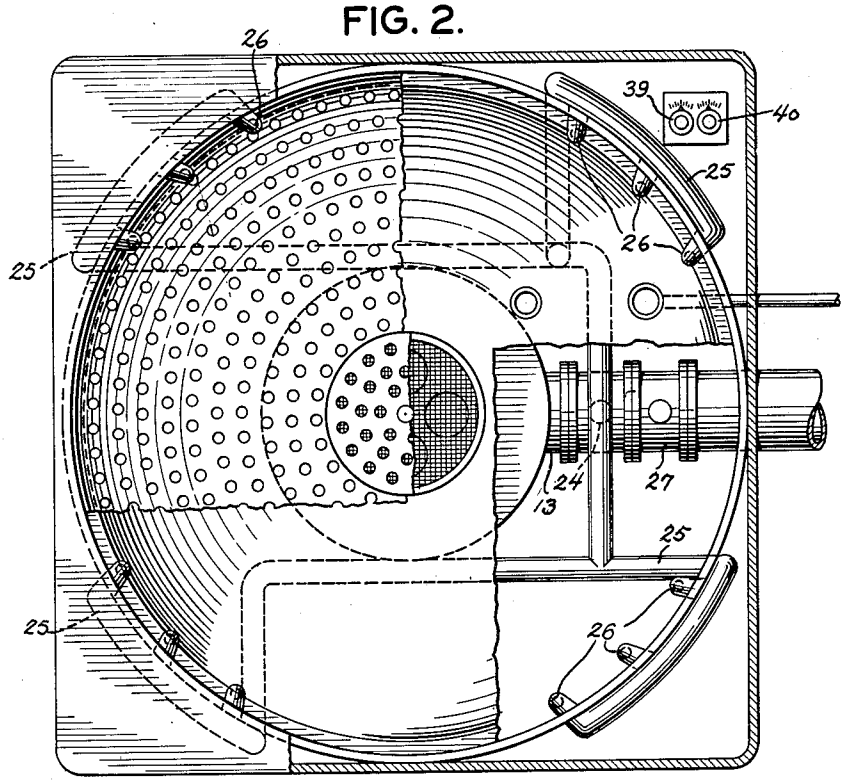
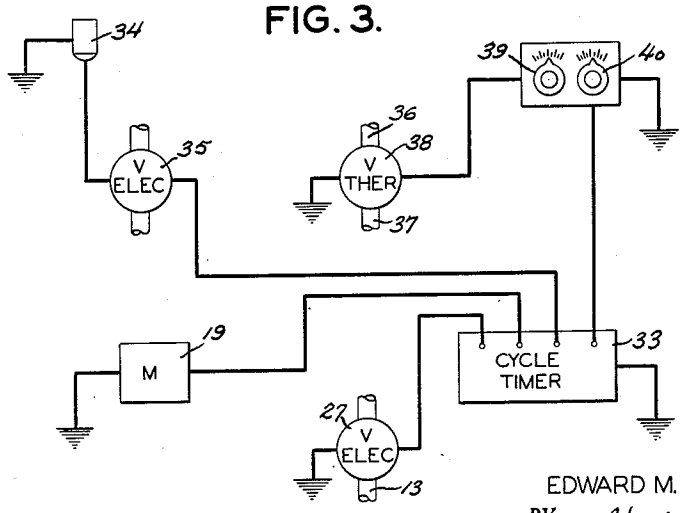


FIG. 3.



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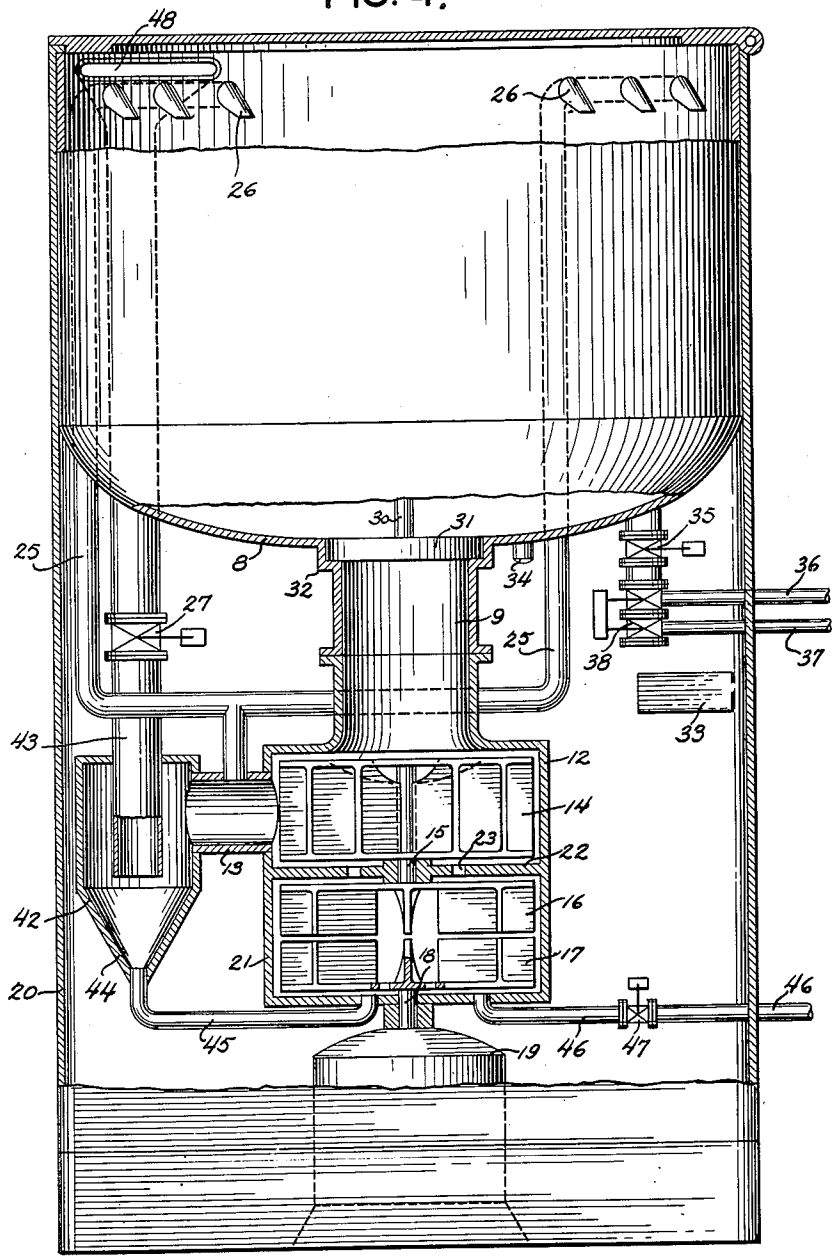
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WASHING MACHINE

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FIG. 4.



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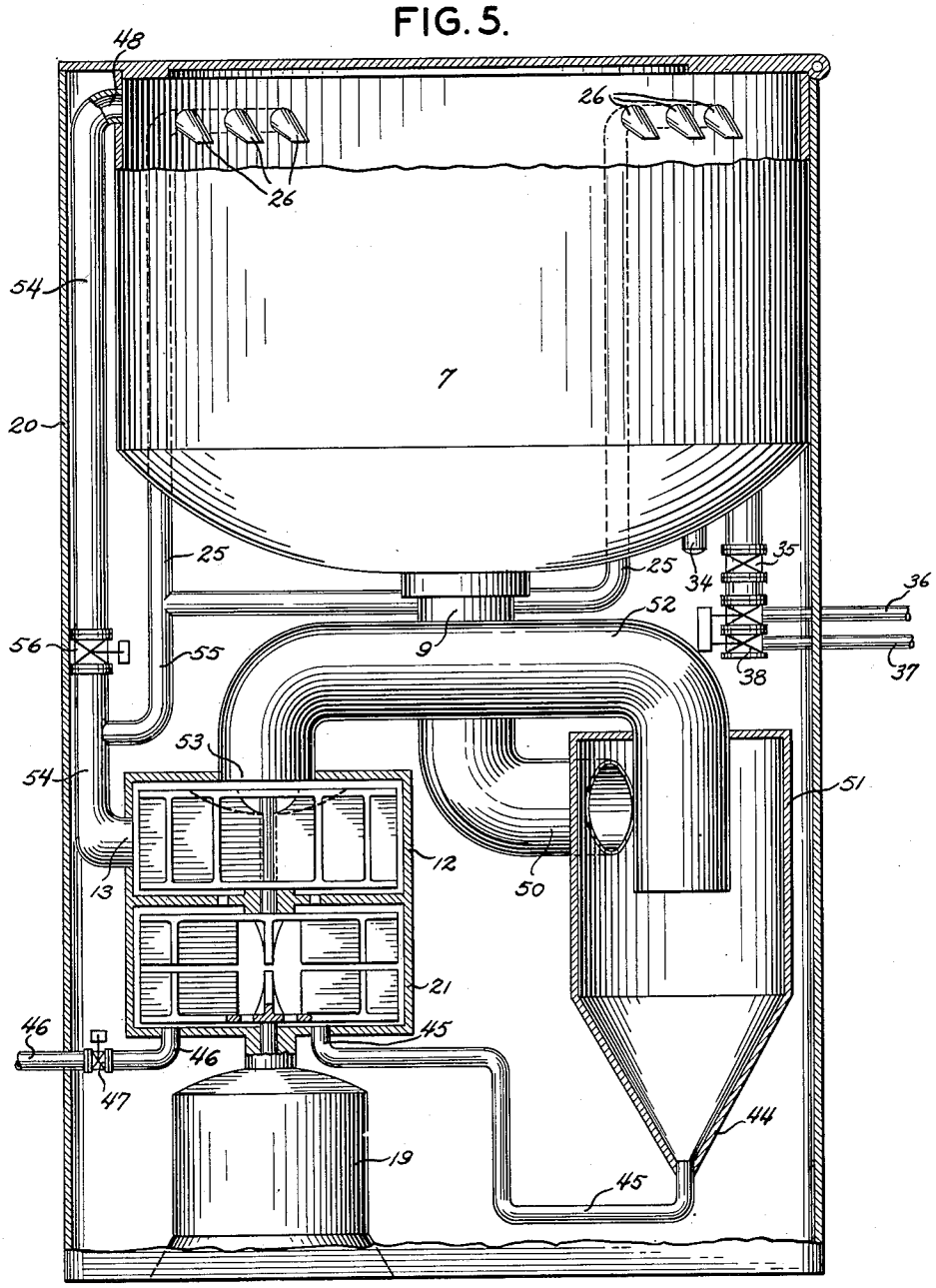
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WASHING MACHINE

Filed April 29, 1948 5 Sheets-Sheet 4

FIG. 5.



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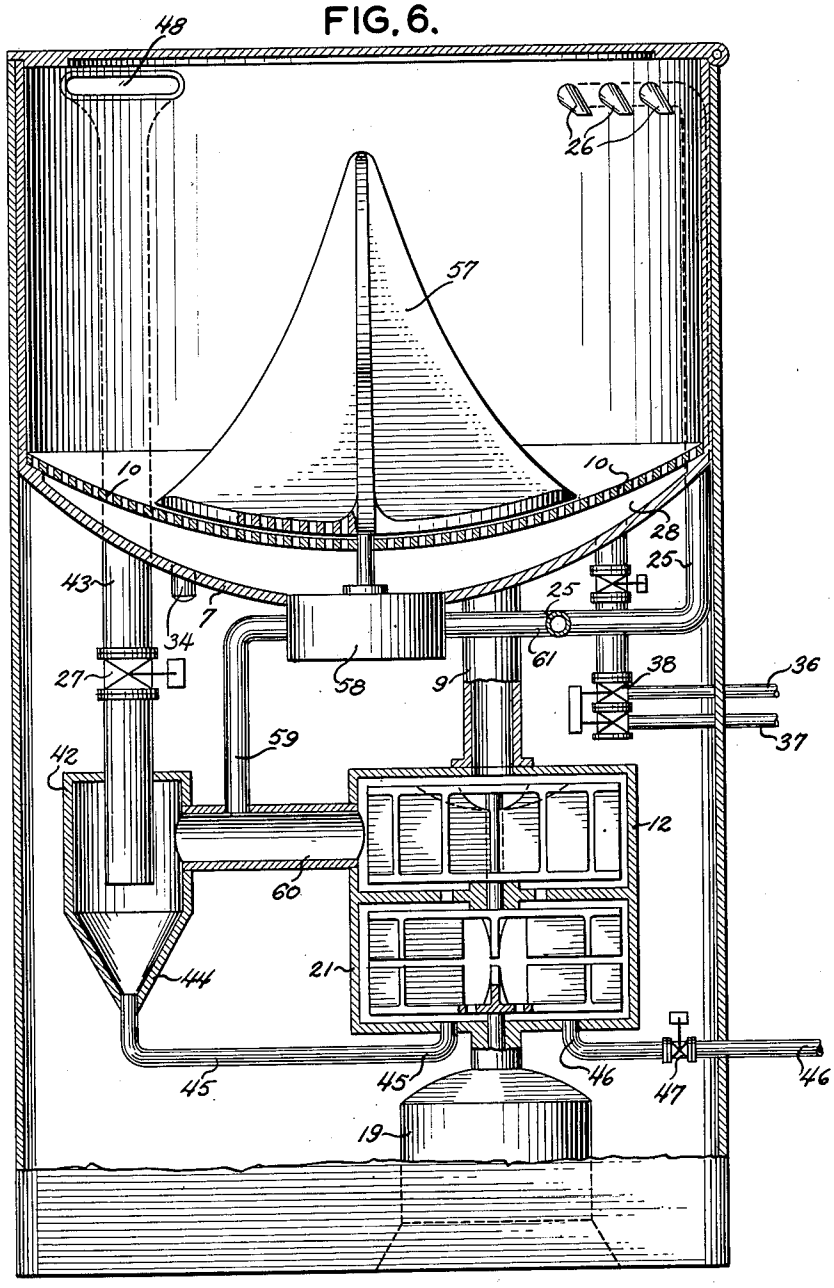
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WASHING MACHINE

Filed April 29, 1948 5 Sheets-Sheet 5

FIG. 6.



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Patented Apr. 21, 1953 2,635,447

UNITED STATES PATENT OFFICE

2,635,447

WASHING MACHINE

Edward M. Van Dornick, Huntington, N. Y.

Application April 29, 1948, Serial No. 23,916

8 Claims. (Cl. 68—20)

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The invention here disclosed relates to apparatus in the nature of clothes washing machines.

More particularly, the invention relates to machines of the automatic washer type in which washing, rinsing and partially drying are accomplished all as parts of one continuous cycle.

Usually in such machines the partial drying is accomplished in a centrifuge stage of operation. Because of the natural unbalance in the mass of wet clothes, this operation usually sets up excessive vibration and this despite efforts to overcome or minimize it by counterbalancing, cushioning and the like.

Important objects of the present invention are to accomplish the drying stage without setting up the objectionable and destructive vibration usually accompanying such operations and to actually attain more efficient and faster drying.

Important objects of the invention also are to accomplish the drying quickly and effectively under complete balance and control and with apparatus of relatively simple construction, few parts, reasonably low cost and economical of operation.

Special objects of the invention also are to combine the washing and drying functions in such manner that the same operating units may be utilized for both functions, continuing in operation from a washing stage directly into a drying stage.

Related objects of the invention are to combine parts so that the same mechanism functioning at one time as a liquid pump may continue on from the washing stage into operation as an air exhausting blower, with automatic change in speed from one rate best suited to one operation, to another rate best suited to the other operation, all with the same continuous drive from the same operating motor.

Other special objects of the invention are to effect, in the change-over or conversion from water pumping to air and liquid extraction operations, the separation of the liquid from the air as the two are withdrawn from the material under treatment.

Further special objects of the invention are to provide self-adjusting and cushioning drive means between the motor and the combination form of pumping unit which in addition to its primary functions will assist and cooperate with other features of the apparatus, such as by removing liquid collecting in the air and liquid separator.

Important objects of the invention additionally are to provide apparatus of the character indicated which will be of simple, rugged construction and generally practical and safe.

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Other desirable objects and the novel features through which the purposes of the invention are attained are set forth or will appear in the course of the following specification.

The drawings accompanying and forming part of the specification illustrate certain present practical embodiments of the invention. Structure, however, may be modified and changed as regards the present illustration, all within the true intent and broad scope of the invention as hereinafter defined and claimed.

Fig. 1 in the drawings is a broken and substantially central vertical sectional view of a washing machine incorporating features of the invention, certain details of control being indicated somewhat diagrammatically;

Fig. 2 is a broken plan and part horizontal sectional view of the machine;

Fig. 3 is a diagram of an automatic control system for the machine;

Fig. 4 is a vertical sectional view of a form of the machine having a liquid separator incorporated in the air exhaust drying system;

Fig. 5 is a similar view illustrating a modified arrangement of the liquid separator; and

Fig. 6 is a like view of another modification employing a mechanical form of agitator.

In the several embodiments of the invention shown there is provided a closed container or tub 7 having a concave, quick draining bottom 8, with a large, generally central discharge outlet 9 and a perforated drainage bottom 10 removably supported on a flange 11 spaced above the true bottom 8.

In the first two forms of the invention illustrated, the central outlet 9 discharges directly into the central suction inlet of a centrifugal suction blower and pump capable of handling both air and water and mixtures of air and water.

The casing 12 of this combination pump-blower is shown as having a combined liquid and air discharge outlet 13 in the side of the same.

The rotor 14 of the pump-blower is shown as having its shaft 15 connected at the bottom with the runner 16 of a hydraulic coupling.

The impeller 17 of this coupling is shown as having its shaft 18 directly connected with or forming a part of the shaft of the motor 19, mounted on the bottom of the casing 20 forming the cabinet or enclosure of the machine. Hydraulic coupling elements 16, 17, are shown as contained within a casing 21 which may in fact be a part of the pump casing 12, substantially as

indicated, with a wall or partition **22** separating the chambers **12**, **21**, for the pump and coupling and provided with one or more passages **23** therethrough for the water, constituting in this case the hydraulic coupling medium.

The centrifugal pump-blower constitutes a means for positively withdrawing the liquid and for then, as it is continued in operation, withdrawing and extracting liquid remaining in the clothes.

Thus after washing is completed the pump-blower may be continued in operation to effect drying or partial drying of the clothes. This drying action, because of the suction applied by the centrifugal blower, is a mechanical separation and removal of the liquid from the clothes, as distinguished from evaporation, though evaporation to some extent accompanies the suction extraction of the liquid.

While mechanical agitation of the clothes may be employed in the washing stage, the blower-pump constitutes present means for accomplishing effective agitation of the clothes by hydraulic force and which may be utilized for such purpose at a time when it is not in service for drying.

Accordingly, there is shown a pressure connection **24** extending from the pump outlet **13**, with branches **25** extended upwardly at the sides of the tub and terminating in nozzles **26** directed into the tub on inclines appropriate for agitating and tumbling the contents of the tub.

Additionally the tub may have agitator bars, ribs or the like on the bottom or side walls of the same to aid in the scrubbing and tumbling operation or, as a further alternative, mechanical agitating means may be used with hydraulic agitation.

During the washing stage described the discharge outlet **13** is closed at a point beyond the pressure take-off line **24**, as by a valve indicated at **27** in Figs. 1 and 4.

The hydraulic coupling at **16**, **17**, is of special utility in the combination considered in that in addition to forming an effective drive connection between motor and pump it forms of itself an automatic variable speed transmission for driving the pump, through slippage under the heavier load, at lower speed, while circulating the liquid under pressure for washing purposes and, as the load is reduced, by elimination of the water, for driving the pump at higher speed during the air exhausting drying stage.

The hydraulic coupling will automatically change from the lower to the higher speed driving relation as the load on the pump decreases. Special means may be provided, however, to more or less arbitrarily control the change in driving relation and hence the speed ratio, as desired.

The perforate inner bottom **10** provides, in effect, a drainage platform supporting the clothes in a more or less uniformly distributed mass with an open space **28** below and entirely across the same, assuring the necessary pressure drop over the entire body of clothes required to accomplish the quick suction drying of the same.

For cleanout and inspection purposes the drainage bottom **10** is shown as having a removable grating **29** at the center connected by a stud **30** with the screen **31** seated on a shoulder **32** at the entrance to the central drain or discharge outlet **9**.

Because of its simplicity and few parts the machine of this invention is particularly well adapted to full automatic control.

In the drawings there is therefore indicated a cycle timer **33**, a liquid level controller **34**, an electrically controlled inlet valve **35**, hot and cold water supply connections **36**, **37**, with thermostatically controlled valve mechanism **38** and controllers **39** and **40** for water temperature and time cycle, these being indicated conventionally in the wiring diagram, Fig. 3, which shows also the discharge valve **27** and motor **19** connected in the cycle timer circuits.

In a typical operation with a fully automatic control system, the machine, once started, will automatically fill to the proper level with water of the proper temperature. With the discharge valve **27** closed the motor will operate the pump through the hydraulic coupling at a proper liquid pumping speed to withdraw the wash liquid through the clothes and down through the tub outlet **9** and back up through piping **24**, **25**, to the agitating and washing nozzles **26**.

At the end of the established washing period the waste valve **27** in the Fig. 1 form of the invention illustrated is opened and the wash water discharged through piping **41** to the sewer or other disposal point.

As the wash water discharges and the pump clears itself of liquid, it automatically changes over to suction blower operation, the hydraulic coupling enabling the rotor **14** to pick up speed as the liquid load reduces until, when clear of liquid, the pump rotor may be turning at full motor speed with the hydraulic coupling operating as a direct drive connection. This change over from liquid to air pumping operation is accomplished smoothly and easily, with the pump rotor speeding up from liquid to gaseous pumping operation. This operation may be continued for a short time, possibly one or two minutes, to remove additional wash water from the bed of wet clothes.

At the end of this first damp dry operation the waste valve **27** is closed and the liquid level controller opens to fill the tub to the proper extent with rinse water of the proper temperature. This rinse water is circulated by the pump through the jet nozzles and may be continued for a period of approximately three minutes to completely agitate and thoroughly rinse the clothes. At the end of this period the waste valve **27** opens to discharge the rinse water and to allow another short damp dry period, usually of one to two minutes.

The rinsing operation is usually repeated and at the end of this second water rinse the waste valve **27** is opened and the final damp drying effected for a period of about five minutes.

At the termination of the final damp dry operation the cycle controller opens the motor circuit, completing the cycle for which the machine was set.

In the operations last described all waste water and air are discharged through the same waste outlet **41**.

In the second form of the invention, illustrated in Fig. 4, the air is separated from the liquid and as the liquid is discharged the air, after removal of entrained water, is recirculated to effect the damp drying.

The air and liquid separator is shown as a cyclone separator **42** arranged with the discharge line **13** from the pump opening into the side of the same and with the waste valve **27** disposed in the gas line **43** extending from the top of the cyclone.

The liquid collecting cone 44 forming the bottom of the cyclone is shown as having a liquid discharge line 45 extended into the bottom of the hydraulic coupling casing 21 near the axis of the impeller 17 and a continuation of this discharge line is shown at 46 extending from the bottom of the coupling casing but at a point further from the center so as to make the impeller function as a low pressure pump for discharging the liquid contents of the machine. This discharge line has a valve 47 which may be controlled by the cycle timer.

The rotor elements of the hydraulic coupling and centrifugal pump may be of conventional open-center construction to create inflow at the center and outflow at the periphery. The relative spacing of the inlet line 45 and outlet line 46 in respect to the center of the coupling impeller determines the effectiveness of this member as a pump for taking liquid separated in the cyclone and passing it out to the sewer or other waste disposal.

In the operation of the invention shown in Fig. 4, at the end of the washing phase the cycle controller opens the waste valve 47 in the liquid discharge line 46 and opens the valve 27 in the gas line extending from the top of the cyclone so that as the water is discarded the pump will step up its operation and act as a blower to pull the air down through the bed of clothes. This air being discharged from the blower at 13, passes through the cyclone 42 where entrained water is removed, and up through the gas line 43 in the top of the cyclone and out through a wide escape mouth 48 into the top of the tub. This recirculation of air may be continued for a period of possibly one or two minutes, as first described.

For the rinsing operations both the water and the air discharge valves 47 and 27 are closed so that with admission of water for rinsing this water will be circulated through the jet nozzles to effect the agitation and circulation of clothes and water in the tub.

The final damp drying is effected with both valves 47 and 27 open, with removal of entrained water separated in the cyclone being effected by the pumping action of the hydraulic coupling impeller 17 and circulation of the drying air effected by the suction blower at 14.

In a typical example for handling a clothes wash of about ten to twelve pounds, the pump unit acting as a liquid pump might circulate sixty gallons a minute through the jets, which on the basis of twelve jets as shown, amounts to five gallons per minute per jet. The pressure drop across the jets to obtain adequate impingement velocity may be an estimated ten pounds per square inch. A motor of low fractional horsepower may be used for this capacity of head. For the damp drying, the pump unit operating as a suction blower would cause a flow of air of about 300 standard cubic feet per minute, at the rate of 100 cubic feet per minute per square foot of tub cross section. This flow rate of air requires a pressure differential across the bed of clothes of four inches of water.

The variable head-capacity characteristics of the pump-blower unit are achieved by means of the hydraulic coupling between the motor and pump-blower unit and which enables the motor to operate at a single effective speed of, say, 3600 R. P. M. at all times, with the rotor of the pump-blower revolving at low speed when pumping water and at high speed when pumping air, thus

utilizing the full power or best efficiency of the motor for both operations.

Additionally the hydraulic coupling provides a shock absorber drive connection between the motor and pump and the effect of a universal joint for correction of any misalignment or other inaccuracies. The machine, therefore, runs smoothly, quietly and in balance at all times. The operation of shifting from pumping liquid to pumping air and vice versa is accomplished automatically and as required, without stopping and starting the motor and while leaving the motor free to run continuously and to apply its power most effectively to the carrying of the load in hand.

The essential elements of the invention are relatively simple and few in number, all motion is rotary and there is practically only a single revolving part since all rotating structure is coupled in compact concentric relation.

Because of the few parts and simplicity of design the machine can be produced at relatively low cost and the cost of operation as well is low.

While the air drying described may be considered primarily for the quick damp drying of wash for putting it in such shape that it may be immediately removed from the machine and hung on the line or ironed, it is possible with a continuation of the suction drying period to effect complete or substantially complete drying, to the extent desired.

The entire drying operation, and in the machines illustrated, the complete washing and drying, are accomplished without handling the clothes and without creating unbalancing forces which would set up vibration or other destructive or objectionable effects.

The drain plate 10 supports the clothes spread out in a bed of more or less uniform density spaced by a plenum chamber 28 above the central tub outlet, and the latter is of large enough size for unimpeded water and air flow from and through the bed. This large size outlet, furthermore, is directly connected with and practically forms the inlet to the suction blower. The full effectiveness of the combination pumping unit is thus made possible.

The hydraulic coupling is self-priming, utilizing the liquid being handled as the coupling medium between the driving and driven elements of the coupling. Through its variable speed driving characteristics this coupling makes it possible to use constant speed or synchronous motors and get the proper speed drive for water and gaseous pumping operations without using gears or the like.

The form of the invention shown in Fig. 5 differs from that last described particularly in having the cyclone interposed between the tub and suction side of the pump, instead of being connected at the discharge side of the pump.

In this view the outlet 9 from the bottom of the tub is shown extended and connected at 50 into the side or inlet portion of the cyclone 51 and the top or outlet pipe 52 of the cyclone is shown extended and connected with the center inlet at 53 of the combined pump and blower 12.

Extending from the outlet side of the pump at 13 is a combined liquid and air discharge pipe 54 and branched off of this is a connection 55 for carrying liquid to the jet supply pipes 25. A valve 56 is located in the main discharge pipe 54.

In operation, with valves 47 and 56 closed, liquid will be withdrawn from the tub and pass through

the separator 51 to the pump inlet 53 and be projected through piping 54, 55 and 25 to the jet nozzles 26.

When valves 47 and 56 are open, liquid and air withdrawn from the bottom of the tub into the suction side of the cyclone will be there separated and the liquid removed from the bottom of the separator through piping 45, 46, and the air taken out at the top through 52 and passed by conduit 54 to the outlet 48 into the top of the tub, the operation thus in this respect being similar to that described in connection with Fig. 4.

One particular advantage of the Fig. 5 form of construction is that dirt and scum removed from the tub is immediately trapped in the separator, before reaching the pump, and is not recirculated through the jet nozzles.

Fig. 6 illustrates a form of the invention designed for mechanical agitation or combination of mechanical and liquid agitation.

In this view a central agitator is indicated at 57, operated by a water motor 58 deriving flow of actuating fluid through a connection 59 from the discharge outlet 60 of the combination blower-pump 12.

The discharge from the water motor 58 is shown passing through connection 61 to the piping 25 supplying the jet nozzles 26, thus to combine the hydraulic with mechanical agitation. If desired, however, mechanical agitation alone may be employed, in which event the discharge from the water motor could be returned into the downtake 9 extending from the tub to the intake of the pump.

This form of the invention, except for the mechanical agitation feature, may operate the same as the construction shown in Fig. 4.

A special and important feature of the hydraulic coupling is that this can never run dry in the normal operation of the machine because the pump inlet 45 and outlet 46 are disposed within the periphery of the annulus of water hydraulically connecting the two coupling elements.

While of particular importance and herein shown as directed to automatic cloth or clothes washing and drying operations, it will be evident that the invention is well suited to other purposes and related operations such as dry cleaning and the like.

What is claimed is:

1. A machine of the character disclosed comprising a rigid clothes containing tub open at the top to atmosphere and having a clothes draining support above the bottom of the same and having an outlet in the bottom below said drainage support large enough for free discharge of both water and air from and through a bed of clothes on said drainage support, a combination suction blower and water pump having a suction inlet connected with said tub outlet and discharge connections for air and water and means for driving said combined suction blower and water pump at a rate for both air and water, including a motor and a hydraulic slip coupling between said motor and said combination suction blower and water pump, a liquid and air separator interposed in said discharge connections and a liquid discharge connection extending from the liquid containing portion of said separator to said hydraulic coupling and a water discharge connection extending from said hydraulic coupling.

2. A machine of the character disclosed comprising a rigid clothes containing tub open at the top to atmosphere and having a clothes draining support above the bottom of the same and having an outlet in the bottom below said drainage support large enough for free discharge of both water and air from and through a bed of clothes on said drainage support, a combination suction blower and water pump having a suction inlet connected with said tub outlet and discharge connections for air and water and means for driving said combined suction blower and water pump at a rate for both air and water, including a motor and a hydraulic slip coupling between said motor and said combination suction blower and water pump, a liquid and air separator interposed in said discharge connections and a liquid discharge connection extending from the liquid containing portion of said separator and an air return connection extending from the air containing portion of said separator back into the tub above the clothes draining support.

3. A machine of the character disclosed comprising a tub having an outlet in the bottom of the same, a combination suction blower and water pump and an air and water separator connected with each other and with said tub outlet and means for driving said combination suction blower and water pump, said means for driving the pump including a hydraulic coupling having an impeller and a water discharge connection extending from the water separating end of said separator to said impeller for utilizing the latter as a pump for removing liquid from the separator.

4. A machine for washing and drying clothes in the same location and as part of one and the same substantially continuous operation, and comprising a washing and drying tub for holding the clothes in washing water during a first, washing stage of operation and adapted to be completely drained of all water for a second, drying stage of operation, said tub having a large water and air outlet in the lowest portion of the bottom of the same arranged to drain the tub free of all water, a perforate clothes support above the bottom of the tub for supporting the clothes in the water during the washing stage and for supporting the washed clothes in a layer spaced above the bottom with clear air space free of water below the clothes during the drying stage, a combination suction blower and water pump having a suction inlet connected with said outlet in the bottom of the tub and having discharge connections for water and air withdrawn down through the clothes in the tub, a motor for operating said suction blower and water pump, a hydraulic coupling between said motor and combination blower and pump and including an impeller driven by said motor and a runner connected with said combination blower and pump, water supply connections extending from said combination blower and pump back to the impeller of said hydraulic coupling for maintaining said coupling effective for the driving of said combination blower and pump, means for effecting agitation of the clothes in the water during the washing stage and means for controlling the discharge from said blower and pump to maintain a closed circulation of water in the tub for washing purposes and to withdraw the complete water content of the tub and thereafter to remove entrained liquid from the clothes resting on the perforate support and whereby said hydraulic coupling will operate automatically to drive the combination blower and pump at lower speed as a water pump during the water

circulating and water withdrawing phases of operation and to drive the combination blower and pump at higher speed as an air suction blower during removal of retained liquid from the clothes in the drying phase of operation.

5. A machine for washing and drying clothes in the same location and as part of one and the same substantially continuous operation, and comprising a washing and drying tub for holding the clothes in washing water during a first, washing stage of operation and adapted to be completely drained of all water for a second, drying stage of operation, said tub having a large water and air outlet in the lowest portion of the bottom of the same arranged to drain the tub free of all water, a perforate clothes support above the bottom of the tub for supporting the clothes in the water during the washing stage and for supporting the washed clothes in a layer spaced above the bottom with clear air space free of water below the clothes during the drying stage, a combination suction blower and water pump having a suction inlet connected with said outlet in the bottom of the tub and having discharge connections for water and air withdrawn down through the clothes in the tub, a motor for operating said suction blower and water pump, a hydraulic coupling between said motor and combination blower and pump and including an impeller driven by said motor and a runner connected with said combination blower and pump, water supply connections extending from said combination blower and pump back to the impeller of said hydraulic coupling for maintaining said coupling effective for the driving of said combination blower and pump, means for effecting agitation of the clothes in the water during the washing stage and means for controlling the discharge from said blower and pump to maintain a closed circulation of water in the tub for washing purposes and to withdraw the complete water content of the tub and thereafter to move retained liquid from the clothes resting on the perforate support and whereby said hydraulic coupling will operate automatically to drive the combination blower and pump at lower speed as a water pump during the water circulating and water withdrawing phases of operation and to drive the combination blower and pump at higher speed as an air suction blower during removal of retained liquid from the clothes in the drying phase of operation, and an air and water separator connected with one side of the combination suction blower and water pump and the water supply connections aforesaid being provided by a conduit extending from the water outlet side of said separator to the impeller of the hydraulic coupling.

6. A machine for washing and drying clothes in the same location and as part of one and the same substantially continuous operation, and comprising a washing and drying tub for holding the clothes in washing water during a first, washing stage of operation and adapted to be completely drained of all water for a second, drying stage of operation, said tub having a large water and air outlet in the lowest portion of the bottom of the same arranged to drain the tub free of all water, a perforate clothes support above the bottom of the tub for supporting the clothes in the water during the washing stage and for supporting the washed clothes in a layer spaced above the bottom with clear air space free of water below the clothes during the drying stage, a combination suction blower and water pump having a suction inlet connected with said outlet in the bottom of the tub and having discharge connections for water and air withdrawn down through the clothes in the tub, a motor for operating said suction blower and water pump, a hydraulic coupling between said motor and combination blower and pump and including an impeller driven by said motor and a runner connected with said combination blower and pump, water supply connections extending from said combination blower and pump back to the impeller of said hydraulic coupling for maintaining said coupling effective for the driving of said combination blower and pump, means for effecting agitation of the clothes in the water during the washing stage and means for controlling the discharge from said blower and pump to maintain a closed circulation of water in the tub for washing purposes and to withdraw the complete water content of the tub and thereafter to remove retained liquid from the clothes resting on the perforate support and whereby said hydraulic coupling will operate aumatically to drive the combination blower and pump at lower speed as a water pump during the water circulating and water withdrawing phases of operation and to drive the combination blower and pump at higher speed as an air suction blower during removal of retained liquid from the clothes in the drying phase of operation, and an air and water separator connected with one side of the combination suction blower and water pump and the water supply connections aforesaid being provided by a conduit extending from the water collecting side of said separator to the impeller of the hydraulic coupling, and air connections extending from the air separating side of said separator back into the top of the tub for aiding in the drying of the clothes.

7. A machine for washing and drying clothes in the same location and as part of one and the same substantially continuous operation, and comprising a washing and drying tub for holding the clothes in washing water during a first, washing stage of operation and adapted to be completely drained of all water for a second, drying stage of operation, said tub having a large water and air outlet in the lowest portion of the bottom of the same arranged to drain the tub free of all water, a perforate clothes support above the bottom of the tub for supporting the clothes in the water during the washing stage and for supporting the washed clothes in a layer spaced above the bottom with clear air space free of water below the clothes during the drying stage, means for effecting agitation of the clothes in the water during the washing stage, a combination suction blower and water pump having a suction inlet connected with said outlet in the bottom of the tub and having discharge connections for water and air withdrawn down through the clothes in the tub, a motor for operating said suction blower and water pump, variable speed drive connections between said motor and combination blower and pump for automatically operating said combination blower and pump at lower speed as a water pump during the washing stage of operation and at higher speed as a large volume, high speed air withdrawal suction blower, as required to entrain the water during the drying stage and means for controlling the discharge from said blower and pump to maintain a closed circulation of water in the tub for washing purposes and to withdraw the complete water content of the tub and thereafter to remove retained liquid from the clothes resting on the perforate support.

8. A machine for washing and drying clothes

in the same location and as part of one and the same substantially continuous operation, and comprising a washing and drying tub for holding the clothes in washing water during a first, washing stage of operation and adapted to be completely drained of all water for a second, drying stage of operation, said tub having a large water and air outlet in the lowest portion of the bottom of the same arranged to drain the tub free of all water, a perforate clothes support above the bottom of the tub for supporting the clothes in the water during the washing stage and for supporting the washed clothes in a layer spaced above the bottom with clear air space free of water below the clothes during the drying stage, means for effecting agitation of the clothes in the water during the washing stage, a combination suction blower and water pump having a suction inlet connected with said outlet in the bottom of the tub and having discharge connections for water and air withdrawn down through the clothes in the tub, a motor for operating said suction blower and water pump, variable speed drive connections between said motor and combination blower and pump for automatically operating said combination blower and pump at lower speed as a water pump during the washing stage of operation and at higher speed as a large volume, high speed air withdrawal suction blower, as required to entrain the water during the drying stage and means for controlling the discharge from said blower and pump to maintain a closed circulation of water

in the tub for washing purposes and to withdraw the complete water content of the tub and thereafter to remove retained liquid from the clothes resting on the perforate support, and an air and water separator connected with one side of said suction blower and water pump, connections for disposing of the water separated by said separator and other connections for carrying the air separated by the separator back into the top of the tub above the perforate clothes support.

EDWARD M. VAN DORNICK.

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