

Nov. 10, 1959

R. F. LANTZ ET AL

2,911,810

WASHING AND DRYING CLOTHES AND THE LIKE

Filed Nov. 6, 1953

5 Sheets-Sheet 1

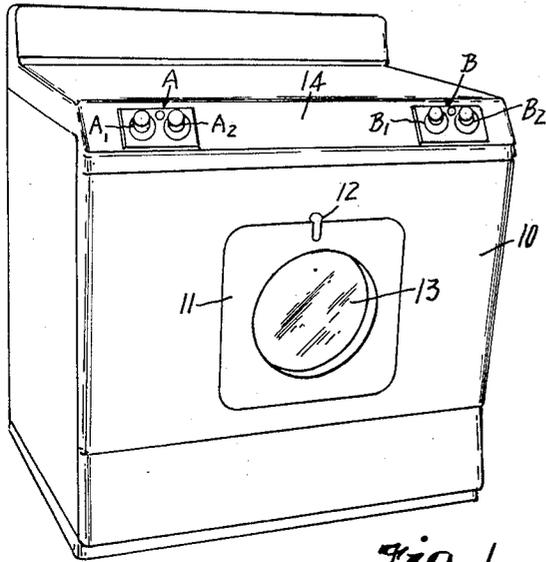


Fig. 1

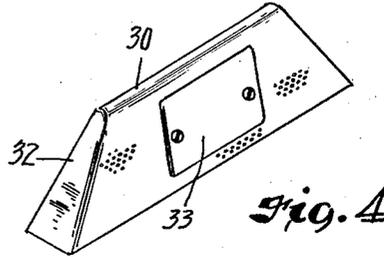


Fig. 4

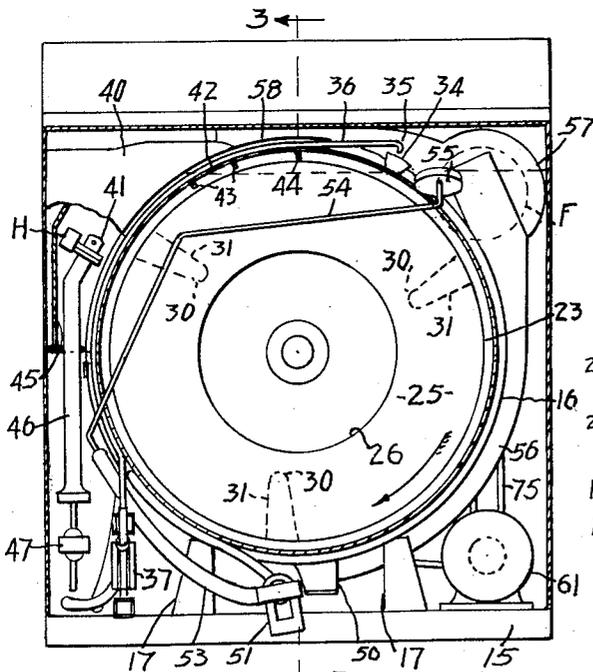


Fig. 2

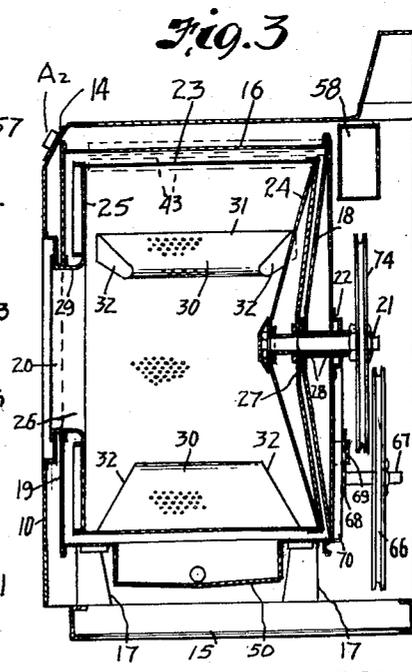


Fig. 3

INVENTORS
 RAY F. LANTZ,
 HARRY B. SCOTT,
 RICHARD L. PERL AND
 TRUMAN B. CLARK

BY Oberlin Limbach ATTORNEYS.

Nov. 10, 1959

R. F. LANTZ ET AL

2,911,810

WASHING AND DRYING CLOTHES AND THE LIKE

Filed Nov. 6, 1953

5 Sheets-Sheet 3

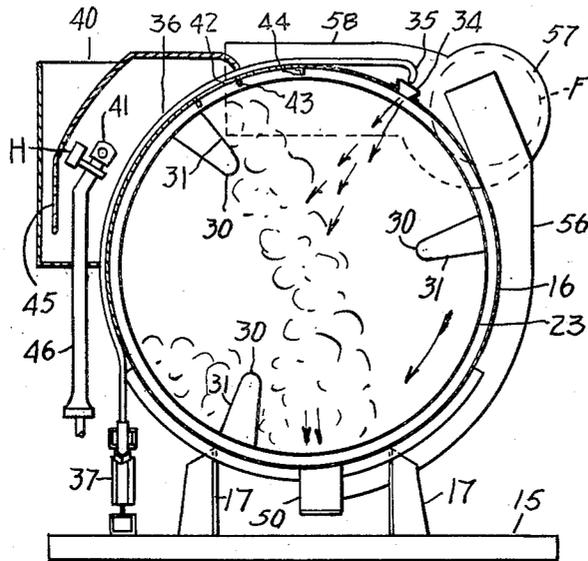


Fig. 8

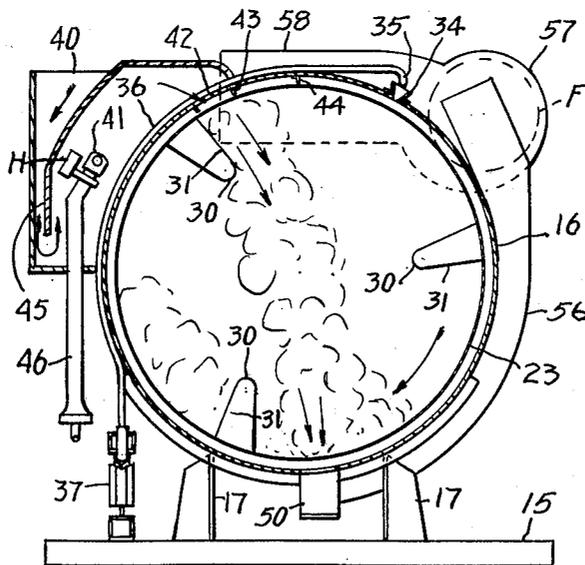


Fig. 9

INVENTORS
RAY F. LANTZ,
HARRY R. SCOTT,
RICHARD L. PERL AND
TRUMAN B. CLARK
BY Oberlin & Simbach ATTORNEYS.

Nov. 10, 1959

R. F. LANTZ ET AL

2,911,810

WASHING AND DRYING CLOTHES AND THE LIKE

Filed Nov. 6, 1953

5 Sheets-Sheet 4

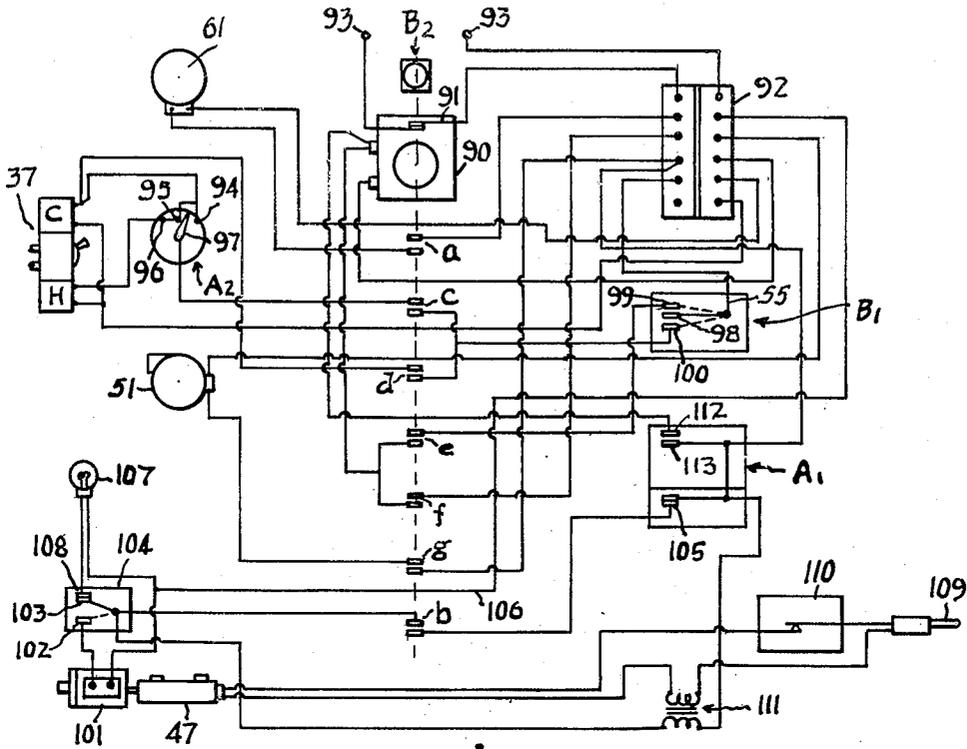


Fig. 10

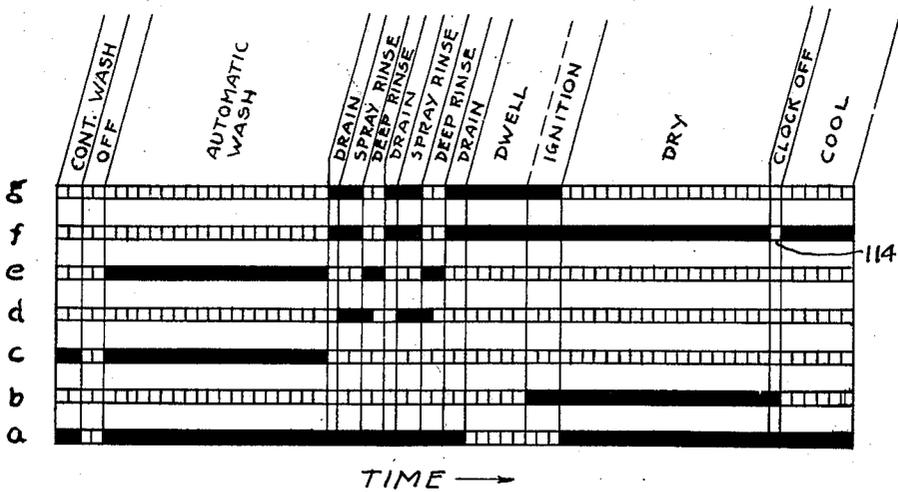


Fig. 11

INVENTORS
 RAY F. LANTZ,
 HARRY B. SCOTT,
 RICHARD L. PERL AND
 TRUMAN B. CLARK.

BY Oberlin Simbach ATTORNEYS

Nov. 10, 1959

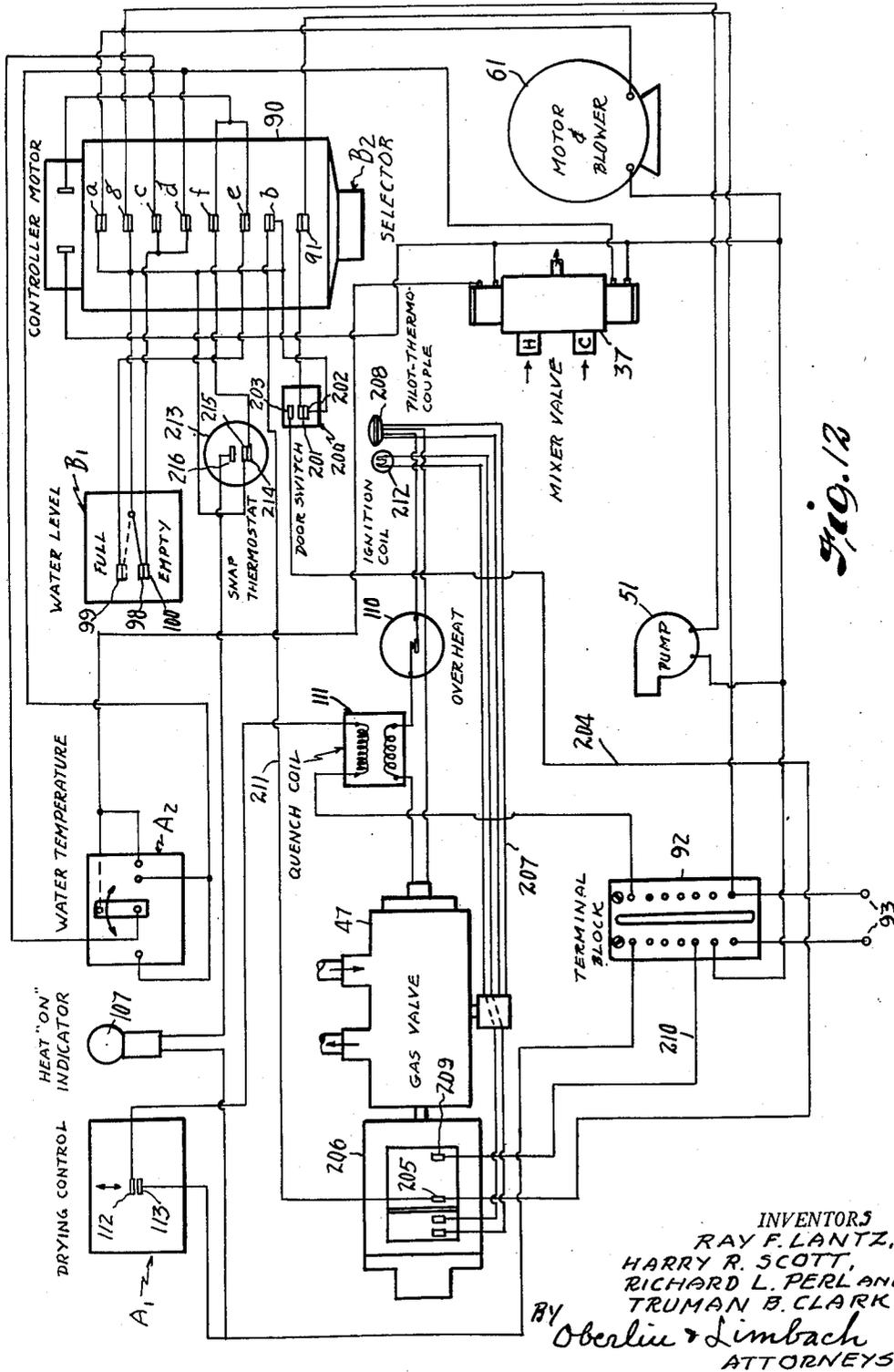
R. F. LANTZ ET AL

2,911,810

WASHING AND DRYING CLOTHES AND THE LIKE

Filed Nov. 6, 1953

5 Sheets-Sheet 5



1

2,911,810

WASHING AND DRYING CLOTHES AND THE LIKE

Ray F. Lantz and Harry R. Scott, Mansfield, Richard L. Perl, Galion, and Truman B. Clark, Mansfield, Ohio, assignors to The Tappan Company, a corporation of Ohio

Application November 6, 1953, Serial No. 390,512

5 Claims. (Cl. 68—12)

The present improvements, relating as indicated to the washing and drying of clothes and the like, have more particular regard to a novel automatic laundry machine especially adapted for household use and characterized by an improved mode of operation.

Commercial large-scale laundry machines have long been known in the art, as have also relatively small machines, which more or less reproduced the action of hand washing. The most time-consuming and burdensome work remaining in the home laundry was, therefore, the handling of the heavy wet clothes while passing the same through a wringer and subsequently hanging them to dry, whether on a clothesline, out of doors, or within a gas heated cabinet. Even when automatic dryers were developed including rotary baskets mounted for high speed centrifugal action, it was necessary for the housewife to transfer the wet clothing from the washing machine to such dryers. Much more recently, combined washing and drying machines have been developed for household use, wherein a horizontally mounted basket is first rotated at fairly high speed to tumble clothes in the wash water and later rotated at still higher speed to centrifuge the water therefrom preparatory to the passage of heated air through the tumbling clothes to dry or substantially dry the same. These operations have been made automatic so that after charging and setting the machine, the housewife may leave it to perform its tasks and return at her leisure to remove the dried clothing therefrom.

A number of disadvantages, however, flow from reliance upon centrifugal force to tumble the clothes and later to extract the rinse water therefrom. The high speeds of rotation necessitate special bearings and transmissions, careful balance both in the design of the machine and the disposition of the clothing therein, special automatic controls to stop the machine in the event unbalance and excessive vibration nevertheless develop, elaborate suspension means to reduce destructive vibration and noise, and very heavy construction generally. Consequently, such a machine is rather complicated and expensive to manufacture and maintain, and its weight serves to increase shipping charges and difficulties of installation. The centrifuging of the water outwardly through the perforations in the drum or basket furthermore tends to drag the fabrics into such openings or perforations with consequent distortion and stressing thereof, this being a particularly undesirable feature in the case of various sheer fabrics.

It is a primary object of our invention to avoid the above-noted disadvantages by providing an improved machine so designed and operated that both washing and drying are achieved therein without the employment of high speed rotation for centrifuging water from the clothes or producing the desired tumbling action.

It is also an object of the invention to improve the washing, rinsing and drying stages of operation of such machine to obtain a highly efficient cleansing action and reasonably rapid drying.

2

Another object is to provide a perforated tumbling basket in a horizontal type laundry machine having baffles or fins designed repeatedly to drain partially and tumble the clothes during a washing operation by mechanically lifting the same out of the wash water and transporting them to the top of the basket without the employment of centrifugal force.

An additional object is to provide a combined washer-dryer designed to achieve a circulation of the clothing axially of the basket as well as circumferentially therein.

It is a further object to provide a combined washer-dryer wherein excess water is effectively drained from the clothes by gravity during a dwell between the washing and drying operations, rather than being extracted by high speed rotation or other mechanical means acting on the clothes.

Another object is to provide a laundry machine of the rotatable receiver type wherein the rate of rotation is held below a certain maximum speed not only to avoid mechanical operating problems, but also to eliminate the necessity for uniform clothing distribution and to avoid the unnecessary wear and tear to which such clothing is subjected by centrifuging.

It is a further object of our invention to provide an automatic control system for a combined washer-dryer which is responsive to water pressure and temperature at certain stages of the operating cycle and automatically timed at other stages of such cycle. Thus, the machine will not proceed to subsequent stages of operation if a preliminary stage has not been properly completed.

A still further object is to provide such a control system including a timer the operation of which is subject to water pressure at the start of washing and in subsequent deep rinsing and to temperature for termination of the automatic cycle.

Other objects and advantages of our improved construction and method of operation will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawings:

Fig. 1 is a perspective view of a machine embodying our invention complete with an outer decorative cabinet;

Fig. 2 is a sectional view of the machine taken transversely just to the rear of the front and control panels to disclose the operating parts;

Fig. 3 is a sectional view taken on the line 3—3 in Fig. 2;

Fig. 4 is an enlarged perspective view of one of the fins with which the basket is equipped;

Fig. 5 is a rear elevational view of the machine;

Fig. 6 is a side elevation as viewed from the left in Fig. 1 with that side cabinet panel removed;

Fig. 7 is a fragmentary plan view of the basket illustrating the action of one fin on a charge of clothing;

Fig. 8 is a simplified front elevation of the machine illustrating the manner in which water is supplied thereto;

Fig. 9 is a view similar to that of Fig. 8, but indicating the hot air supply and circulation through the basket;

Fig. 10 is a diagrammatic representation of a control system for the machine;

Fig. 11 is a time chart indicating the periods of energization of the several control circuits which make up the control system of Fig. 10; and

Fig. 12 is a diagram of a slightly modified control system.

Referring now to the drawings in detail, and particularly to Fig. 1, it will be seen that the operating parts of our machine are enclosed within a cabinet comprising top, front and side panels, with the front panel 10 having a door 11 therein which may be opened to permit clothing and other fabrics to be placed in and removed from the machine. Door 11 is provided with a conventional latch 12 and observation window 13.

Since our tub assembly is mounted independently of the cabinet structure, as will appear hereinafter, it is preferred that the cabinet panels be individually readily removable for facility of inspection and maintenance of the operating mechanism. The manually settable controls used are grouped in pairs indicated generally at A and B and mounted on a separate control panel 14 which is slightly inclined to enhance readability of the control settings.

The front and side panels of the cabinet are suitably interengaged at their adjoining edges, and removably secured at their bottoms to the base 15 which supports the tub assembly. The tub 16 is mounted on the base by means of the several support posts 17, and it will be noted that the tub is thus rigidly secured and mounted on the base wholly independently of the enclosing cabinet.

Tub 16 is cylindrical and provided with an inwardly curved rear wall 18 and a forward wall 19 in which an opening 20 is provided. A shaft 21, supported by a cross bar 22 extending transversely of the tub rear wall, extends through such wall and axially rotatably supports the perforated tumbling basket or drum 23.

The basket has a generally conical rear wall 24 to which the forward end of shaft 21 is secured, and a front wall 25 having an opening 26 aligned with the opening of the tub. Both the front and rear basket walls are imperforate; and a splash guard 27 is provided to deflect liquids away from the fit of shaft 21, mounted in sleeve type bearings 28, with the tub rear wall 18. As will be seen in Fig. 3, a resilient sealing ring or gasket 29, having a smooth inner surface so as not to interfere with proper tumbling of the clothes, is positioned in the openings of the front panel and tub to engage the door and further seal the space between tub and cabinet.

Arranged in circumferential uniformly spaced relation about the inner wall of the basket 23 are three fins 30 adapted repeatedly to lift and drop the clothes when the basket is rotated. It is to be noted that each such fin is asymmetrical with respect to the basket radii, and in this manner, the leading surfaces 31 of the fins, with the basket normally rotating in a clockwise direction as shown by the arrow, are angled slightly forwardly with respect to the direction of basket rotation. The fins are of substantial height, preferably equal to approximately one-third of the basket radius, and are abruptly bevelled at the ends 32 thereof to provide relatively unobstructed portions at the respective ends of the basket. As shown, the fins are likewise perforated, with the exception of the ends 32, and of hollow construction with the hollows thereof communicating directly with the space between the basket and tub walls.

The door sealing ring 29 extends inwardly to the basket opening 26 to prevent pieces of the laundry placed in the machine from being accidentally deposited in the forward space between the tub and basket. However, the ring is deformable, and in machine operation small pieces, such as handkerchiefs, socks and the like, may be worked into such space and travel to the bottom of the tub outside the basket wall. In order to provide an operator convenient access to this space so that any such articles may be readily retrieved, one of our fins 30 is modified as shown in Fig. 4 by the provision of a door 33 therein. The door is located in the trailing fin side with respect to basket rotation and is of a size such to permit an operator's hand to pass easily therethrough. Since the fins are hollow and set in substantial openings in the basket wall to communicate directly with the space between such

wall and the tub wall, it will be obvious that an operator can, with the machine stopped, open door 33 and reach into the space. By rotating the basket manually access may be had in this manner to the entire annular space between basket and tub.

An opening 34 is provided in the upper side wall of the tub at a point slightly to the right of center as viewed from the front, and water supplied therethrough by means of the spaced nozzle 35 which is connected by tube 36 to the water mixing and supply valve indicated generally at 37. Leading from such valve are two hoses 38 and 39 adapted to be connected to the hot and cold water supply pipes.

At the top of the tub and to the left of center when viewed from the front is an air supply manifold 40 within which a gas burner 41 is positioned to heat the air circulating through the same. It will be understood that the source of heat need not be a burner of this nature, but may as well be an electric heater or other suitable heating means, as desired. The manifold communicates with an opening 42 in the tub wall and baffles 43 located in the adjacent space between the tub and basket confine the air supplied through such opening. These baffles may be attached as separate elements or may be formed by turning the side edges of the opening 42 inwardly. In order to insure against any spray from the water nozzle entering the burner box, an additional baffle 44 may be provided at the drum top as shown. Baffle 44 can be added as a separate element or the drum edges at a seam in the wall thereof turned inwardly and located at the top to serve the same function, the latter arrangement additionally strengthening the drum. Manifold 40 has an outer wall 45 spaced both from the adjacent cabinet side panel and the closed manifold bottom, as shown, while the end walls and bottom extend to the panel. This construction forms a duct for the air drawn through the manifold which requires the same to flow across the top, down the outside of wall 45 and into the manifold through the opening between the lower end of this wall and the bottom. The burner neck 46 is supplied with gas through a conventional control valve 47 which is in turn connected to a source of gas by means of the hose 48, preferably through a suitable regulator, not shown. A manually operable valve 49 may be provided in the gas line before the automatic valve and such regulator.

Both the water and air are, therefore, supplied to the tub and basket near the top thereof, and a common sump 50 is provided at the bottom of the tub for removal of the same. Connected to the sump is a water pump 51 operative to withdraw the water collected therein and to discharge it through an outlet hose 52. Also connected to the pump by means of the hose 53 and tube 54 is a water pressure responsive switch 55 having a control function to be described hereinafter.

At the opposite side of the sump is a duct 56 leading in a direction generally opposite to that of basket rotation and curving about the right side of the tub to the housing 57 within which an exhaust blower F is mounted. This blower operates to withdraw air from the tub through the sump 50 and to discharge the same into the outlet duct 58 having an exhaust opening 59 at the top rear of the cabinet. A removable screen filter 60 is provided in the exhaust opening.

As will appear most clearly from Fig. 5, a single drive motor 61, likewise mounted on the base 15, is provided to drive both the shaft 21 for rotating the basket and the blower shaft 62. Connected to the motor shaft 63 by a sheave 64 is a drive belt 65 which also engages about a much larger sheave 66 on an intermediate jack shaft 67. This latter shaft is secured at its inner end to a slide plate 68 movable vertically in the bracket 69 attached to a channel member 70 on the drum rear wall and is resiliently biased by means of spring 71 engaged therewith and with a bracket 72 on the base of the machine. The shaft 21 is driven from shaft 67 by means of the

5

further belt 73 connected to sheave 66 and to a large pulley or sheave 74 on the former, the indirect drive of shaft 21 providing the necessary reduction in basket speed of rotation. In order to afford ready adjustment of the tensioning of both belts 65 and 73, bracket 69 is slightly wider than plate 68 so that shaft 67 may be laterally, as well as vertically, adjusted. If desired, suitable gearing may be used in lieu of part or all of the illustrated belt transmission. Although the blower F need be operative only in the drying stage of machine operation, and, therefore, could be controlled accordingly, we have shown the drive motor shaft 63 connected directly to blower shaft 62 by the belt 75. In this arrangement, which is economical in that no particular blower control is required, the blower will operate whenever the drive motor is energized.

In the operation of our machine, the basket 23 is rotated by the drive means described at a constant speed insufficient to centrifuge appreciably the contents thereof in either the washing or drying stage of machine operation. The speed of rotation at which the clothing will be noticeably centrifuged is dependent in part upon the diameter of the basket, and may be calculated in accordance with known principles. In Reissue Patent No. 22,375, the centrifuging action of machines of this general type is discussed in detail and the minimum speed for centrifuging indicated as determinable by the following formula:

$$\sqrt{\frac{2500}{\text{Drum radius in feet}}}$$

It is, therefore, quite easily determined at what speed any given diameter basket may be rotated without centrifuging the contents thereof. As a specific example, we have operated a machine with a basket having a diameter of 26" and found a speed approximately equal to 36 revolutions per minute to be optimum for our purposes with average loading of such a machine. This speed may be revised somewhat both upwardly and downwardly, for example, with variation in the type and amount of fabrics to be treated, and we have found a range on the order of 30 to 42 r.p.m. to be satisfactory, with a preferred intermediate range of 34 to 38 r.p.m., for a basket having a diameter in the neighborhood of two feet. The axial length of this basket is approximately equal to two-thirds the diameter thereof.

Before considering the overall machine operation and automatic cycling thereof, the action obtained individually in the successive stages of washing, rinsing, and drying will be set forth.

Washing

Due to the fact that the basket 23 is rotated at slow speed, reliance is placed solely upon the fins 30 to accomplish the desired lifting and dropping, or tumbling, of the clothing or other fabrics placed therein. As noted earlier, these fins are of substantial height and have forwardly inclined leading surfaces 31 as well as sharply bevelled ends 32. In a washing operation, the machine is, of course, partly filled with water at a desired temperature and a suitable soap or detergent is added thereto. It is preferred that the level of washing solution should not exceed the approximate height of the fins, or in other words, one-third the basket radius, although such level may be lower than this if the charge of clothing is below normal weight.

As the basket is rotated at a speed such that the contents will not be centrifuged, the fins 30 move through the washing solution and pick up a portion of the clothes. Because of the noted relationship between the fin height and the maximum liquid level, movement of the clothes through the solution will also carry along a major portion of the latter, with the result that the liquid level behind a thus moving fin is substantially reduced. With reference to Fig. 7, this movement also creates a substantial coun-

6

terflow around the bevelled ends 32 of the fin which tends to move the clothes or portions thereof at the respective ends of the mass axially inwardly as shown by the arrows. In this manner, a portion of the clothes mass tends to be displaced in a generally axial direction.

The fins 30 will carry the clothes to a considerable elevation before the same will drop and fall across the basket. It will be seen from Fig. 8 that the falling clothes strike the basket in an unobstructed portion thereof and approach the same at a large angle. This is to be distinguished from a centrifugal tumbling action wherein the falling clothes follow an elliptical path and engage the basket at a small angle, almost tangentially. Because of the large angle and the fact that the liquid level in the landing zone has been substantially reduced by the action of the next succeeding fin, as explained, the clothes will land with considerable impact which effectively jars wash water, dirt particles and the like therefrom. The clothes are then picked up by another fin and this action repeated for the duration of the washing operation.

Due to the slow speed of operation, the falling clothes are not subjected to a uniform force, as in a centrifugal machine, and when dropped may fall to different points along the basket axis. In other words, the tumbling of the clothes is not wholly circumferential, but subject to various axial influences as well. This, of course, assists in exposing the clothes surfaces to maximum extent and thereby improves the cleansing action. By leading duct 56 to the right of the sump, or generally opposite to the basket rotation, rather than to the left, any tendency for water to be forced up the same is reduced and a more efficient use of the water obtained.

Rinsing

As noted earlier, the water inlet nozzle 35 is located adjacent the opening 34 in the side wall of the tub near the top thereof and in advance of center. The opening is, therefore spaced forwardly of the dropping point of the clothes, and as shown in Fig. 8, the nozzle 35 is directed at an angle such that the water is sprayed in a path convergent to that of the falling clothes. The point of impingement is below the actual dropping point and, of course, lateral relative to the clothes. Nozzle 35 preferably discharges the water in a fan-shaped spray extending generally lengthwise of the basket to facilitate passage through the basket openings and to subject substantially all exposed surfaces of the falling clothes directly to the spray. This arrangement provides excellent rinsing, since the clothes are distributed axially and unfolded or spread out in falling, the spray being directed against the side of the thus distributed mass.

It will be evident that in machines of this type wherein the laundry is tumbled in a substantially horizontal basket, the side of the falling mass of laundry exposes much more of the surfaces thereof than do the respective ends. A lateral spray of considerable velocity, such as we provide, is, therefore, considerably more efficient in removing wash water, detergents and the like from the clothes than an end spray. It is also to be noted that in our rinsing, the dirt is not forced through the clothes but is carried along by the water falling down on the outside of the same. The machine may be operated to provide a series of spray rinses of the nature set forth either with or without deep rinsing, the latter being comparable to the washing action discussed above.

Drying

The improved drying action will now be described with reference to Fig. 9 wherein the clothes are again shown following the tumbling path. It will be understood as the clothes become progressively drier, they become fluffed out and, therefore, require more volume for proper tumbling than would normally obtain in a machine designed solely for washing. In our combined washer-dryer this

added volume requirement is adequately met by the sharp bevelling of the fin ends, which permits the drying clothes to expand into the relatively unobstructed basket end portions. While the conical rear wall of the illustrated basket 23 protrudes only slightly into the basket, as shown, this wall could be made flat if additional space is desired.

As indicated in the foregoing, the general circulation of heated air produced by the blower is downwardly through the basket. The intake air for manifold 49 must be drawn across the cabinet top and around the tub, by virtue of the duct formed partially by manifold wall 45, and the resultant circulation of air beneath the top cabinet panel particularly prevents the same from becoming undesirably hot. In addition, the incoming air will be preheated by contact with the exhaust duct 56 and the tub walls. After passing over the burner 41, the air is directed by the baffles 43 into the basket. The baffles are so positioned that the air is supplied at the approximate dropping zone of the clothes, and since the air is removed at the bottom of the container, it will flow in a path generally coincident with the falling clothes, thereby to obtain maximum absorption of moisture therefrom. It is to be noted, however, that the clothes fall to a point slightly to the rear of the sump 50 so that the air must actually go through the falling clothes to be withdrawn. These two actions, namely the general flow with the clothes, and the crossing over of the respective paths of air and falling clothes enables the latter to be completely dried in a reasonably rapid time.

The tendency for the clothes to become displaced axially noted in connection with the washing action also obtains in drying but for a different reason. In washing, it will be remembered, the counterflow of liquid around the fin ends tends to carry some or portions of the clothes therewith. Tests of the drying operation have been conducted with varied colored pieces of fabric and, by viewing the tumbling action through the door window, it has been observed that such pieces appear, move out of sight, and later re-appear, thus indicating that generally axial displacement also occurs in this stage. It is believed, in this instance, that the clothes are actually continually pushed into the basket end regions in spreading out and pulled back by the fin engagement causing random but definite axial circulation in addition to the normal circumferential distribution.

Since the basket is operated at a relatively low speed, it is possible to supply both the water and air thereto in the manner described. If the basket were rotated at high centrifuging speeds, the perforations would require to be quite small to prevent damaging distortion of the fabrics therethrough by centrifugal force, and the combination of high speed and small openings would militate against the type of supply set forth above. For this reason, centrifuging machines ordinarily supply the water and air from an end of the machine, generally the front end, with a consequent reduction in efficiency of operation.

However, in our construction it is possible to use perforations of fairly large diameter, and it is preferred that the same be on the order of one-fourth inch in both the basket 23 and fins 30. The fins being open at their bases, which are of considerable area, and also perforated, do not present any obstruction to either the water or air supply. In fact, they tend to facilitate the water spray action.

The above three stages of machine operation are, of course, combined to provide complete cleansing and drying of the clothes, and although the rinsing particularly is subject to variation in the number and type of rinses provided, the overall machine operation includes an essential step in the extraction of excess water before drying. It has been noted that such water has conventionally been extracted by centrifuging and further that our improved machine is specifically designed to avoid any high speed operation. In lieu of spin extraction, we provide a dwell

period intermediate the washing and drying operations during which the basket, and hence the clothes, are held stationary for a predetermined interval to permit the excess water to drain therefrom by gravity.

Actual tests have shown that such a dwell period on the order of five minutes is sufficient to remove enough excess water from the clothes so that the same may thereafter be thoroughly dried in a reasonable time which compares favorably to that of machines employing spin extraction. In one test, nineteen pounds of thus drained excess water was removed from the machine by our drying in one hour, this period of time being approximately that required to dry completely a normal laundry load on the order of seven pounds in the machine given as a specific example in the foregoing. A period of ten minutes is usually sufficient for washing. The complete operation, therefore, comprises low speed tumbling of the clothes in both washing and drying, such that the clothes are not centrifuged, with an intermediate stationary period of predetermined duration between the two.

Control

The complete operation of the combined washer-dryer will perhaps be best understood if described in connection with a control system useable therewith. One such system is illustrated in Fig. 10, to which reference is now made. The machine is equipped with four controls, A₁, A₂, B₁ and B₂ which may be manipulated by an operator conveniently at the front of the machine to select the desired washing and drying conditions. Control A₁ is a conventional thermostatic switch suitably positioned so as to be responsive to temperature within the tub and adjustable in well-known manner, A₂ is operative to regulate the temperature of the water supplied to the tub from the mixing valve 37, likewise conventional, B₁ controls setting of the liquid pressure responsive switch 55, and B₂ is a selector for conditioning the machine to perform the particular operation desired by the operator.

Selector B₂ is operatively associated with a sequence controller 90 of a commercially available type comprising a clockwork mechanism, not shown, and a plurality of switch contacts operable thereby in accordance with a preset sequence. The selector itself is also conventional and has a shaft which may be moved axially as well as rotated to selected position. The axial movement is here utilized to control the main line contacts 91 which connect the terminal block 92 to the supply terminals 93 when closed, while manual selector rotation makes and breaks the respective controller contacts dependent on the degree of rotation, as well-understood in the art. In this system, the sequence controller 90 operates the switch contacts indicated at *a* through *g* with the closure of such contacts being indicated in operative sequence by the filled-in blocks of the correspondingly designated lines of the time chart of Fig. 11.

Assuming now that it is desired to perform a manually controlled washing operation, the operator will, after charging the machine, actuate control B₁ to obtain the proper amount of water for the particular load, set control A₂ for the desired water temperature, and rotate selector B₂ to a manual setting either before or after moving the knob axially, preferably outwardly. The first noted adjustment determines the tub water pressure at which switch 55 will operate automatically to stop the water supply. This switch comprises a contact member 98 connected to one side of terminal block 92 and movable in response to tub water pressure between the two contacts 99 and 100. When the tube is empty, contact 98 engages contact 100 which is connected through contacts *c* to the control A₂; when the tub is full, that is, at the selected amount, contact 98 will engage with contact 99, the latter being connected through contacts *e* to one side of the controller 90. The operator, therefore, adjustably sets the condition at which contact member 98 moves out of engagement with contact 100 to interrupt

the energization circuit of water supply control A_2 . While the extreme limits of switch 55 as described correspond to empty and full conditions, it will be apparent that the lower limit could be set at a value slightly less than full so that the tub would not require to be empty to start the supply of water. This latter arrangement would serve to maintain the proper water level more closely.

By adjusting control A_2 , the operator moves the contact 97 thereof into selective engagement with one of the further contacts 94, 95 or 96. Contact 94 is connected to the cold side only of mixing valve 37; contact 95 to both cold and hot sides; and contact 96 to the hot side only. The two sides of the valve are also connected directly to the terminal block 92 to complete the respective circuits therethrough, and, either or both sides may, therefore, be energized through contact 97, controller contacts c , and the switch 55 to supply cold, medium or hot water to the tub. The energization and metering actions of the valve, as indicated earlier, are conventional and well-known.

When the operator sets selector B_2 at manual control position, contacts 91 will close to connect terminal block 92 to the source of energy contacts 93, and controller contacts a and c will also close. Closure of contacts a completes the circuit connecting drive motor 61 to the terminal block, while the closing of contacts c will connect valve 37 to the block through the particular selected contacts of control A_2 and the contacts 98 and 100, the latter being engaged since the tub is empty of water at this point.

Water at the selected temperature will, therefore, be supplied to the tub until the proper amount is reached. At this point, contact 98 disengages from contact 100, thus de-energizing the mixing valve circuit and stopping the water flow. Drive motor 61 will continue to rotate the basket to tumble the clothes in the washing solution, a soap or detergent having been added, until the operator stops the machine by returning selector B_2 to off position. The manual selector position is indicated by the first two-filled-in blocks of lines a and c in the Fig 11 chart.

If, instead of the above-described manually controlled washing, the operator desires automatic operation, selector B_2 is moved to a correspondingly marked position to close controller contacts e in addition to contacts 91, a and c . Controls A_2 and B_1 will, of course, have been set as in the above, and the tub will be filled properly with the wash water. Closure of the additional contacts e connects one side of controller 90 to contact 99 of switch 55 which, it will be remembered, is engaged by contact 98 of the same switch when the desired amount of water is in the tub. The controller energization circuit is completed by a further direct connection to the terminal block 92, and initial energization is, therefore, dependent on water in the proper amount being in the tub. With such condition, washing will proceed for a predetermined period of time indicated by the line e in Fig. 11.

At the end of this period, the controller 90 operates to close contacts f , thereby establishing a holding circuit directly across the terminal block. Contacts g are also closed to energize pump 51, and the washing solution is withdrawn from the tub. The holding circuit prevents de-energization of the sequence controller due to the resultant decrease in water pressure causing contact 98 to move out of engagement with contact 99 and into engagement with contact 100.

Shortly thereafter, as shown in Fig. 11, contacts d are closed by the controller to energize a separate circuit to the cold side only of mixing valve 37 through contacts 98 and 100 of the switch 55. This provides cold water for the rinsing spray. Pump 51 is operative to remove water from the tub during the spray rinse period and then de-energized by opening of contacts g by the controller. Contacts f of the controller holding circuit are opened at the same time, and the water level will rise in the tub to provide a deep rinse. When the previously selected

liquid level is reached, movable contact 98 will disengage from contact 100 and move into engagement with contact 99 to de-energize the mixing valve and connect the sequence controller to the terminal block.

After this deep rinse of a duration determined by the controller, energization of the controller is again shifted by closure of the contacts f and opening of contact e , the pump 51 is again energized, and the rinse water supply temporarily interrupted by opening of the contacts d . The rinse water is again supplied after a short interval, and the controller operative after a further period to open the contacts g and f and closing contact e to provide a second deep rinse in a manner similar to the first. Thus, there are provided two rinses in which the clothes or other fabrics are subjected to both spray and deep rinsing. It will be obvious that the number and type of rinses may be varied as desired.

At the end of the final rinse, the sequence controller closes the circuit to the pump and the holding circuit to remove the water from the tub, and, as shown in Fig. 11, the motor circuit is next interrupted by opening of the contacts a . Such contacts are held open for a predetermined interval to afford the dwell period discussed in the foregoing. During this period, the tub and wet clothes will be stationary, and excess water draining from the latter by gravity will be removed by the pump, which is continuously operative in this portion of the cycle.

When the dwell period has substantially expired, switch contacts b in the heater circuit are closed, and at the end of the dwell, the motor circuit contacts a are closed to retumble the clothes. Contacts g are opened at the same time to shut off the pump which will now remain inoperative for the remainder of the cycle. The slight time delay between the closing of contacts b and a is to permit ignition of the gas burner by any suitable means such as a continually burning gas pilot flame without wasting the ignition time. Contacts b connect one side of a gas valve solenoid 101 to terminal block 92 through contacts 102 and 103, of a heat actuated mercury switch 104, and an operating overheat thermostat 105 responsive to tub temperature. The other side of solenoid 101 is connected directly to the terminal block by lead 106. An indicator lamp 107 connected to a second contact 108 of the switch 104 provides a visual signal of the burner operation.

Valve 47 is of a type commonly used to provide a controlled flow of both pilot and main burner gas, and is here under joint control of solenoid 101 and a burner thermocouple 109, the latter having a failure overheat thermostat 110 responsive to burner box temperature and a quench coil 111 in circuit therewith. Valve 47 includes a solenoid coil operable by weak electric current from thermocouple 109 to hold the valve in open position, once it has been opened by solenoid 101. Heavier current to the solenoid valve 47, such as provided from the secondary of quench coil 111, serves to pull the armature of this solenoid to a further advance position, closing the valve. From this second position the valve can be re-opened only by operation of solenoid 101. Solenoid 101 is operative whenever energized to close the normally open main gas outlet and open the valve inlet, so that the valve can supply only pilot gas, while the inlet, once opened by the solenoid, is held open by proper operation of the thermocouple circuit. As shown, the quench coil is in parallel with the operating safety thermostat 105 responsive to tub temperature so that the coil will be energized to interrupt the normal thermocouple control of the gas flow when this thermostat opens.

In operation of the burner, solenoid 101 will first be energized through the normal engagement of contacts 102 and 103 to permit pilot gas to flow through valve 47. Switch 104 has its mercury bulb located in housing H adjacent the burner to be responsive to pilot temperature and is essentially a time delay device for ignition. When the pilot has been on for the period required to raise its temperature to the operating value of switch 104, contact

103 disengages from contact 102, thereby de-energizing the solenoid and energizing indicator lamp 167 to signal that the burner is on. With proper ignition, heating of the thermocouple 109 will have rendered the same operative to hold the valve open, and the thermocouple circuit will thereafter control the gas supply. Should operating thermostat 105 open in response to excessive tub temperature, the resultant energization of quench coil 111 will cause the gas valve to be shut off. Note that the primary of the quench coil is short circuited through contacts 165 and contact *b* except when contacts 165 open in response to excessive temperatures. The primary or quench coil is then energized from terminal block 92, completing the circuit through the moderate resistance of indicator light 107. Likewise, the valve will be closed if failure thermostat 110 opens due to the temperature of the burner box becoming too high, for example, as the result of a blower failure stopping the normal flow of air through the box.

In normal drying then, air will be heated by the burner and circulated through the basket to absorb moisture from the tumbling clothes in the manner set forth previously. This operation will continue for an initial predetermined period of time, after which sequence controller 90 will open contacts *f* in its holding circuit, as indicated at 114 in Fig. 11. Completion of the drying is now dependent upon closure of contacts 112 and 113 of the adjustable thermostat A₁, which may conveniently be calibrated in terms of degree of dryness of the clothes. In fully automatic machine operation, the desired adjustment of the thermostat will, of course, be made when initially conditioning the machine to perform the complete cycle.

Contacts 112 and 113 will close to connect the controller through a separate circuit to the terminal block when the selected temperature is reached. Should the tub not be at such temperature when contacts *f* are opened, the automatic cycle is not reestablished until this condition exists. When these contacts do close, or if they are already closed at the point of interruption 114, the controller immediately again closes contacts *f* and opens contacts *b*, the latter action stopping the supply of heat. The motor continues to tumble the clothes for a further period to permit the same to cool and the controller then opens contacts *a*, *f* and 91 to shut off the machine.

It will be apparent from the above that an operator may, by suitably actuating selector B₂, alter or select particular portions of the described automatic cycle as desired, and, therefore, that the rinsing and drying stages, as well as the washing, are subject to manual control and modification. Since the machine operates throughout at uniform speed, there is no limitation on movement of the selector, as commonly encountered in spin extracting machines wherein the motor speed requires to be gradually increased and thus the selector provided with special guards and the like to insure a particular sequence of controller contact engagement in this stage.

In Fig. 12, we have illustrated a modified, and preferred, control system which differs from that of Fig. 10 principally in the circuits controlling operation of the valve 47 and, hence, of the gas burner. A further change is the inclusion of a door switch as a safety feature to shut off the machine if the door is opened during operation, without, however, interrupting the flow of burner pilot gas. Unless indicated otherwise in the following, those components common to both systems, shown by the like reference characters, are operative as described in connection with Fig. 10.

The door switch, indicated generally at 200, is comprised of a first stationary contact 202 commonly in circuit with the several controller contacts *a* through *g* and a movable contact 201 connected to the control side of the main switch contacts 91. Contact 201 is suitably actuated by the door to engage with contact 202 when

the door is closed and with a second stationary contact 203 when the door is open. It will be clear that contacts 201 and 202 must be engaged for the machine to operate, and, therefore, that the machine will be stopped if running when the door is opened.

A wire 204 connects door switch contact 203 to one terminal 205 of the primary winding of a solenoid 206, here used to control the pilot gas supply through the valve 47. This gas flows from the valve through a line 207 to the pilot 208, which is, of course, positioned adjacent the main burner to ignite the same. The other terminal 209 of the solenoid primary is connected directly to terminal block 92 by wire 210, and the solenoid will, therefore, be energized when door switch contacts 201, 203 and the main switch contacts 91 are engaged. Terminal 205 is also connected by a wire 211 directly to the control side of the contacts *b* to form a separate, and actually the normal, energization circuit for the solenoid. The solenoid secondary winding supplies low voltage energy to the ignition coil 212.

The main gas flow through valve 47 is again under control of the thermocouple 109, which may be combined with pilot 208 to form a unitary assembly, in circuit with the failure overheat thermostat 110 and quench coil 111. In this case, however, the quench coil primary is connected across the terminal block through the contacts 112, 113 of the control thermostat A₁ to be energized by closure thereof. With this arrangement, the main gas supply is shut off when the thermostat A₁ operates in response to tub temperature. A slightly different starting of the burner operation is also obtained by means of the snap thermostat 213 inserted in circuit with the controller holding contacts *f*. Thus, the stationary contact 214 of this thermostat is connected to one side of contacts *f*, while the movable contact 215 normally engaged therewith is connected to the common lead from the door switch. The thermostat is located above the burner, and when actuated in response to the temperature thereof, contact 215 breaks with contact 214 and engages a further contact 216, the latter being connected to the terminal block through the indicator lamp 107.

In operation of this modified system, adjustment of the several controls will be made as in the Fig. 10 system, and the machine will proceed similarly through the washing, rinsing, and dwell stages, subject, however, to interruption by opening of the door. The closure of contacts *b* shortly before the end of the dwell energizes solenoid 206, by means of the wires 210 and 211, and gas and energy will be supplied to the pilot and ignition coil, respectively. The controller contacts *f* are closed at this point, the same having been closed after the final deep rinse, so that the controller is energized by its holding circuit. After a short period for ignition of the pilot, contacts *b* are opened to de-energize the solenoid, the thermocouple holding valve 47 open as in the Fig. 10 system, and heating of the snap thermostat by the burner will cause the same to break the controller holding circuit and energize the signal lamp. Operation of the controller will, therefore, be stopped with contacts *a* and *f* closed.

Since contacts *a* remain closed, the motor continues to run, driving the basket to tumble the clothes and the blower to circulate the heated air, all as previously set forth. If the operator happens to open the door in this drying stage, the motor will be stopped by the action of the door switch, and the solenoid will be energized through closure of contacts 201 and 203 to shut off the supply of gas to the main burner while continuing the pilot gas supply. The flow of gas to the pilot will be maintained, with the burner off, while the door is open, so that it is unnecessary to re-ignite the pilot after the door is again closed. When the drying has progressed to the point where the tub is at the temperature selected by adjustment of control thermostat A₁, the contacts 112 and 113 will close to energize the quench coil 111.

This shuts off the burner, and snap thermostat 213 cools to re-establish the controller holding circuit. The controller runs for a further time to provide cooling of the clothes to safe handling temperature and then shuts off the machine.

It will be seen that operation of the controller contacts in the modified system will be as represented in the Fig. 11 time chart except for the opening of contacts *b* at the end of the dwell period and elimination of the break 114 in the closure of contacts *f*. Rather than providing an initial timed drying period, as in the Fig. 10 system, with the noted break to test tub temperature, the drying operation obtained with the system of Fig. 12 is initiated by proper burner functioning and terminated as soon as the control thermostat is actuated. The particular pilot control afforded by the door switch permits the main burner, once operating, to be shut off if the door is opened without requiring closure of contacts *b* to re-ignite the pilot. It will also be evident that the Fig. 12 control eliminates the heat-actuated mercury switch used as a timer for the pilot in the system of Fig. 10.

Reviewing generally the normal automatic operation provided by both systems, an operator will place a charge of clothing in the basket and add a quantity of soap or a detergent. The controls A_1 , A_2 and B_1 will be adjusted to select the desired degree of dryness, the wash water temperature, and the amount of such water to be used, respectively. After next moving selector B_2 to the automatic position marked thereon, the operator can then leave the machine unattended and it will proceed to wash and dry the clothes, shutting itself off when the operation is completed.

The basket rotates to lift and drop the clothes repeatedly without centrifuging thereof, and water is supplied in the selected amount. The clothes are tumbled in the wash solution for a predetermined time, and such solution is then withdrawn from the tub and basket. A succession of spray and deep rinses follows to remove wash water and soap curds from the clothes, with the rinse water spray striking against the side of the clothes as they fall.

The basket rotation is next stopped and excess water allowed to drain from the clothes as the same are held stationary in the bottom of the basket. After this dwell period, the basket is again rotated at a non-centrifuging speed; and hot air now circulated downwardly there-through to absorb moisture from the tumbling clothes. When the clothes have been thus dried to the desired degree, whether this be partially or completely dry, operation of the machine will stop.

Because of the shifting nature of the control employed, the automatic operation will not proceed to subsequent stages in the cycle if a preliminary stage has not been properly completed. Thus, the automatic operation will not begin at all unless the proper amount of wash water is in the tub, the rinsing is likewise dependent upon the proper amount of water in the tub, and completion of the drying operation dependent on the attainment of the preselected tub temperature. The control, therefore, is not determined solely with respect to time, but is both time and condition responsive. Not only does this insure against improper operation, but it also provides self-compensation for the common variable factors which influence the time required to perform the washing and drying. For example, the amount of time required to fill the tub is obviously dependent upon the pressure of the water supply, and variations in such pressure would change the effective washing time if this operation was allotted a fixed time period. Likewise, the moisture content of the ambient air drawn in and circulated through the basket to dry the clothes will be variable and hence affect the amount of time necessary to dry the clothes to the desired degree.

While we have described a specific embodiment of our

washer-dryer in detail as required by the patent statutes, it will be evident that various changes may be made both in the structure disclosed and its particular manner of operation. Certain possible modifications have been mentioned in the foregoing, such as, the use of an electric heater in lieu of a gas burner to supply heat for drying, and variation in the number and type of rinses normally provided. In addition, closed systems for the circulation of the water and air may be used; a water condenser may be added to remove moisture and lint from the air before exhausting the same.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims, or the equivalent of such, be employed.

We therefore particularly point out and distinctly claim as our invention:

1. In a laundry machine wherein clothes and the like are washed and thereafter dried in a common receiver including, a substantially horizontally disposed perforated rotary receiver, a constant speed drive means including a motor operative to rotate said receiver at a sub-centrifuging speed to tumble the clothes, water supply and inlet means adjustably controlled to supply a preselected charge of water to the machine, a timer operative to de-energize said motor after a predetermined washing period, pump means under control of said timer and operative to remove water from the machine, heating means adapted to conduct heated air through the receiver and clothes for drying the washed clothes and rendered operative by the timer after a dwell period of motor de-energization and pump means operation during which excess water is permitted to drain from the clothes and the receiver, said timer energizing the motor at the end of the dwell period to re-tumble the clothes as heated air is supplied thereto, means for stopping further operation of the timer shortly after the heat supply is commenced, and means adjustably operative in response to machine temperature to shut off the heat and start the timer again when the desired temperature is reached in the machine, the timer thereafter causing the motor to drive the machine for a further period to permit cooling of the clothes.

2. In a laundry machine wherein clothes and the like are washed and thereafter dried in a common receiver including, a substantially horizontally disposed perforated rotary receiver, drive means adapted to rotate said receiver and tumble the clothes therein, water supply means operative to supply a charge of water to the machine, a timer operative to de-energize said drive means after a pre-determined washing period, means under control of said timer and operative to remove water from the machine, drying means adapted to conduct heated air through the receiver and clothes for drying the washed clothes and rendered operative by the timer after the water is removed from the machine, said timer re-energizing the drive means after the water is removed, means related to the timer for stopping further operation of the timer shortly after the drying means is put into operation, and heat responsive means related to the timer and adjustably operative to response to machine temperature to shut off the drying means and start the timer again when the desired temperature is reached in the machine, the timer thereafter causing the drive means to rotate the receiver for a further period to permit cooling of the clothes therein.

3. The laundry machine as defined in claim 2 wherein said substantially horizontally disposed perforated rotary receiver is provided with a plurality of circumferentially spaced, radially outwardly opening, hollow, perforated fins projecting inwardly from the inner surface of said receiver and extending longitudinally thereof, said fins each projecting inwardly approximately one-third

the radius of said receiver and having sharply beveled ends to afford relatively unobstructed regions in the respective end portions of said receiver, said fins adapted to carry a charge of clothing to be washed upwardly together with a substantial portion of the water and to drop such clothes in a generally vertical direction from the upper part of said receiver as the receiver turns.

4. A combination washer and dryer including a horizontally disposed tub having end walls and a cylindrical side wall, said side wall having air and water inlets in its upper portion, an elongate substantially horizontally disposed basket having end walls and a perforated annular side wall rotatably supported in said tub and adapted to receive clothes to be washed, constant speed drive means adapted to rotate said basket at sub-centrifugal speed and tumble the clothes therein, water supply means operative to supply a charge of water to the basket through said water inlet and said perforated side wall of said basket, a timer operative to de-energize said drive means after a predetermined washing period, means on the control of said timer and operative to remove water from the machine, drying means rendered operative by the timer after the water is removed from the machine, said drying means including an air inlet manifold communicating with said air inlet opening, a burner in the manifold to heat the air therein, and a blower adapted, when the driving means is actuated, to draw heated air from said manifold downwardly through said inlet opening and through the perforated basket and clothes therein, said timer re-energizing the drive means after the water is removed, means related to the timer for stopping further operation of the timer shortly after the drying means is put into operation, and heat responsive means related to the timer and adjustably operative to response to machine temperature to shut off the drying means and start the timer again when the desired temperature is reached in the machine, the timer thereafter causing the drive means to rotate the basket for a further period to permit cooling of the clothes therein.

5. A combination washer and dryer including a horizontally disposed tub having end walls and a cylindrical side wall, said side wall having circumferentially spaced air and water inlet openings in its upper portion and a sump in its lower portion, a substantially horizontally disposed, cylindrical basket having end walls and a perforated annular side wall rotatably supported in said tub and adapted to receive the fabrics to be washed, electrically operated drive means adapted to rotate said basket at a constant sub-centrifuging speed to tumble the fabrics therein, water supply means operative to discharge water into the tub and including an electrically operated water valve connected with a suitable water supply, a delivery tube extending from said water valve to the top of the tub and a nozzle at the end of the tube

and directing a spray of water through the water inlet opening and through the perforations in the basket when the valve is actuated, a timer operative to de-energize said drive means after a predetermined washing period, electrically operated pumping means under control of said timer and operative to remove water from the tub and including an electrically driven pump connected with said sump, electrically operated drying means adapted to conducted heated air through the basket and clothes for drying the washed clothes and rendered operative by the timer after the water is removed from the machine, said drying means including an air inlet manifold open to atmosphere and communicating with the air inlet opening, an electrically controlled burner in the manifold to heat the air therein, and an air duct communicating with the sump and projecting upwardly therefrom to terminate above the normal water level in the tub, an electrically driven blower at the upper end of the duct and adapted when energized by the timer to draw heated air from the manifold downwardly through the inlet opening and through the perforated basket and the fabrics therein, means related to the timer for stopping further operation of the timer shortly after the drying means is put into operation, and heat responsive means related to the timer and adjustably operative in response to machine temperature to shut off the drying means and start the timer again when the desired temperature is reached in the machine, the timer thereafter causing the drive means to rotate the basket for a further period to permit cooling of the fabrics therein.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 22,375	Chamberlin et al. -----	Sept. 14, 1943
954,802	Hawley -----	Apr. 12, 1910
1,387,776	Henning -----	Aug. 16, 1921
1,469,975	Wagenhals -----	Oct. 9, 1923
2,048,743	Huebsch et al. -----	July 28, 1936
2,225,407	Bassett -----	Dec. 17, 1940
2,236,748	Chayie -----	Apr. 1, 1941
2,272,027	Sutton -----	Feb. 3, 1942
2,288,141	Oliver -----	June 30, 1942
2,296,258	Breckenridge -----	Sept. 22, 1942
2,357,909	Ridge -----	Sept. 12, 1944
2,361,767	Hays -----	Oct. 31, 1944
2,406,494	Ferris -----	Aug. 27, 1946
2,503,556	McCarger -----	Apr. 11, 1950
2,574,985	Russell -----	Nov. 13, 1951
2,607,209	Constantine -----	Aug. 19, 1952
2,633,728	McKendree -----	Apr. 7, 1953
2,656,695	Miller -----	Oct. 27, 1953
2,827,783	Handley -----	Mar. 25, 1958