June 14, 1960 L. L. HENDERSON 2,940,287

DRY CLEANING APPARATUS AND ELECTRICAL SOLUTION CONTROL DEVICE

Filed Feb. 1, 1954 2 Sheets-Sheet 1

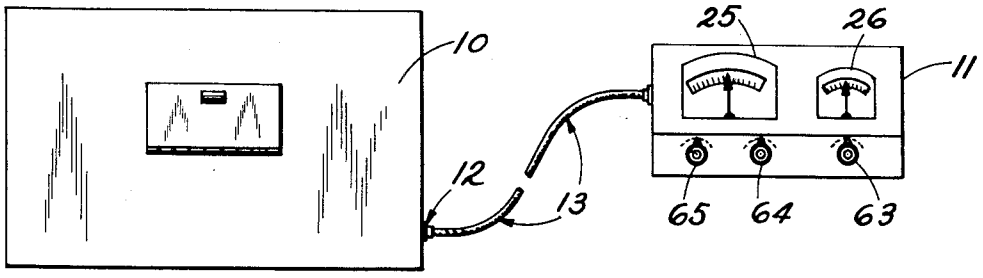


Fig. 1

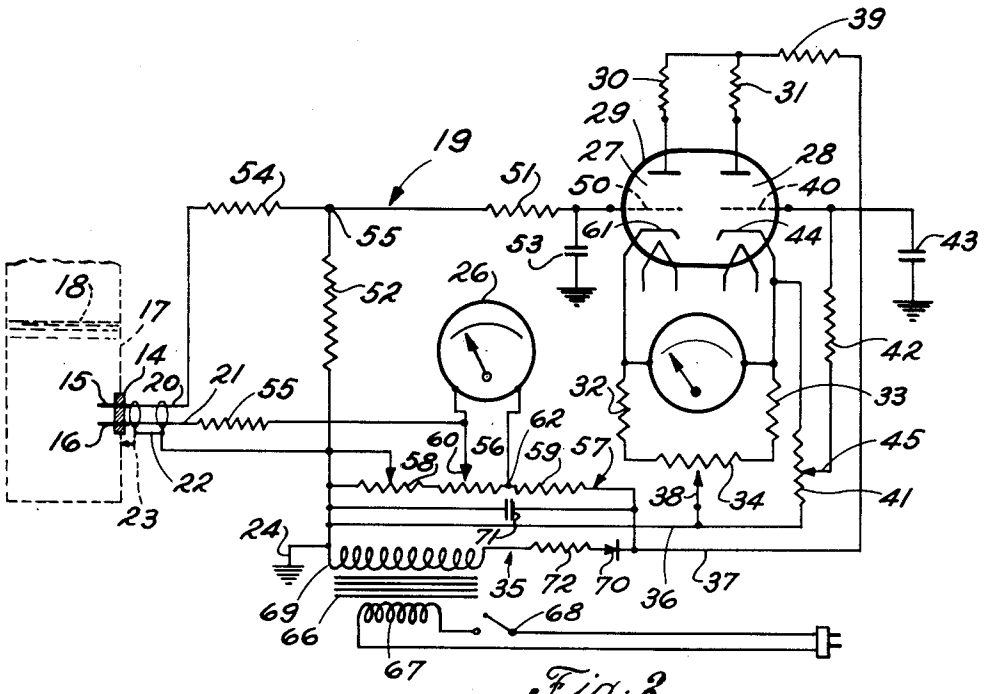


Fig. 2

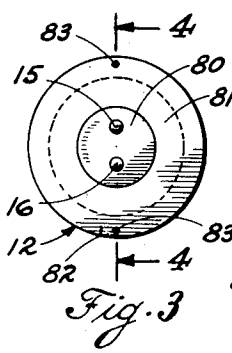


Fig. 3

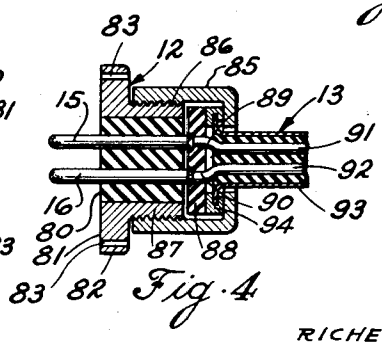


Fig. 4

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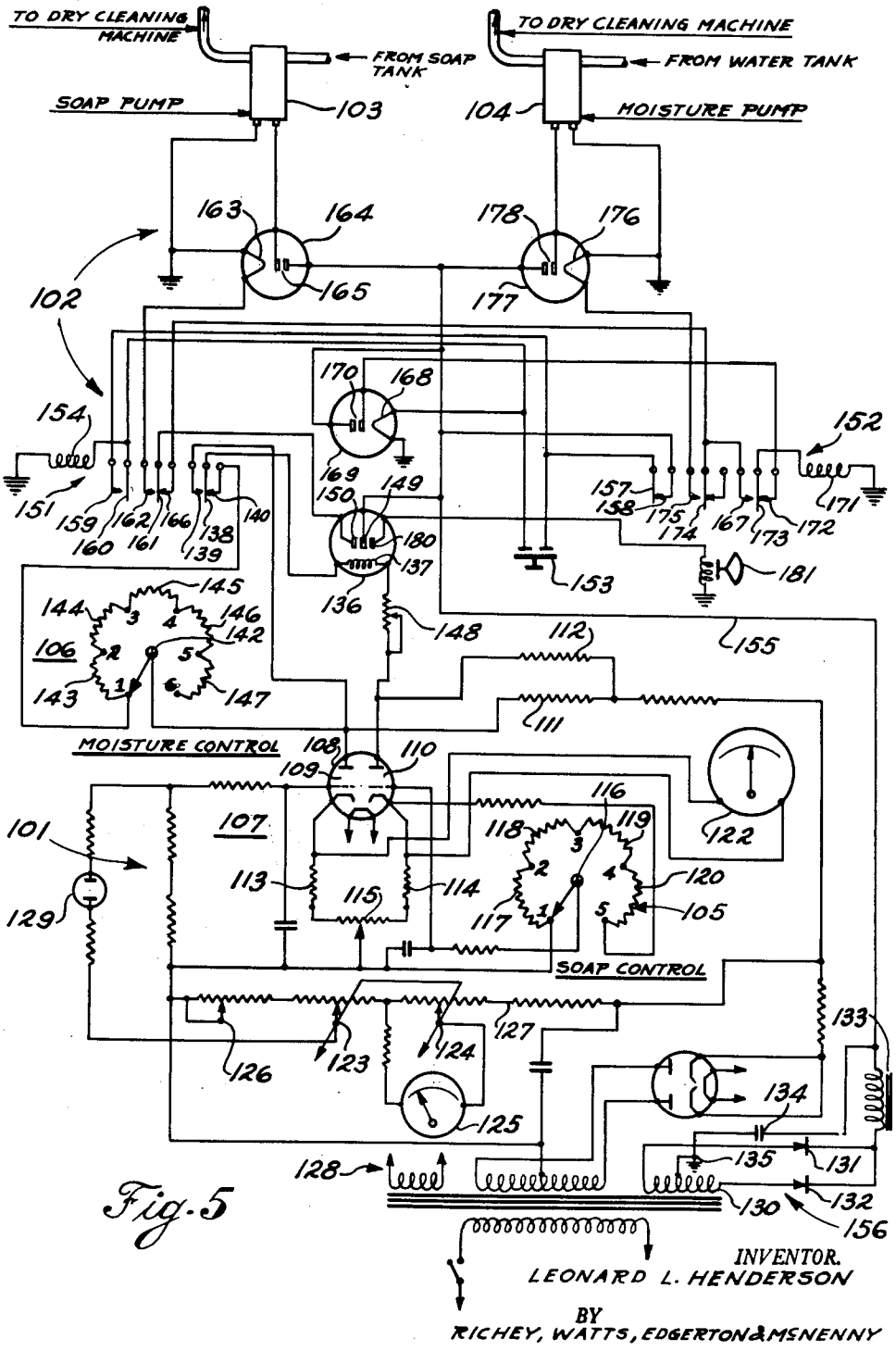


Fig. 5

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DRY CLEANING APPARATUS AND ELECTRICAL SOLUTION CONTROL DEVICE

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8 Claims. (Cl. 68—13)

This invention relates to dry cleaning and, more particularly, to a method of and means for maintaining the proper proportions of solvent, soap and moisture in the dry cleaning fluid.

An object of the invention is to dry clean garments and the like by means of a solution having a predetermined optimum proportion of component liquids.

Another object of the invention is to maintain an optimum amount of moisture in a dry cleaning solution.

Still another object of the invention is to maintain a proper ratio of soap to moisture in a dry cleaning solution.

A further object of the invention is to provide dry cleaning apparatus in which the proper proportions of soap and moisture are automatically maintained in the cleaning fluid.

A still further object of the invention is to provide a dry cleaning machine in which optimum dry cleaning conditions are automatically maintained for each load of garments.

A still further object of the invention is to provide a highly sensitive and accurate means for determining the electrical condition of a liquid solution having a very high order of resistivity.

In dry cleaning operations such as are ordinarily conducted in commercial dry cleaning establishments, certain conflicting requirements are imposed upon the manager of the establishment. It is highly desirable in dry cleaning garments and the like that a dry cleaning solution be used in which there is an optimum amount of moisture for the amount of soap which is combined with the solvent. The optimum proportions of moisture, soap and solvent are well known and may be determined from charts which are readily available. However, in the operation of a laundry machine, it is essential that an excess of moisture not be used inasmuch as such an excess of moisture will cause the garment to wrinkle or shrink. Such a result leads to substantial expenses by reason of the resulting damage to the garments.

On the other hand, the use of insufficient moisture in the solution tends to leave the garments in a spotted condition, e.g. moisture is essential to the removal of certain types of water soluble stains. Under such circumstances, the spots must be removed by hand with the resultant increase in overall cost of cleaning.

The difficulty has heretofore been in the lack of adequate means whereby the condition of the cleaning fluid might be determined within the necessary limits of accuracy and without expenditure of a great deal of time.

It is the purpose of the invention herein set forth and described to overcome the above-mentioned difficulties and to provide the operator of the dry cleaning establishment with a continuous measure of the condition of the cleaning fluid.

The invention as herein conceived and embodied is concerned with the operation of a dry cleaning machine in such a way that the cleaning fluid is maintained in a condition such that there is a substantially constant ratio between the amount of solvent and the amount of soap and the amount of moisture combined with the solvent. There is provided an electronic measuring device which, by determining the hindrance of the dry cleaning fluid to a very minute electric current, provides an indication of the amount of the moisture in the fluid. The arrangement is such that the cleaning fluid constitutes one arm of a vacuum tube bridge which is balanced so as to eliminate the effect of the conductivity of the solvent. As a result, even very small changes in the quantities of soap and moisture may be detected and shown by the resulting electrical unbalance of the bridge circuit.

In one form of the invention, the condition of the cleaning fluid is indicated by a visual indicating device so that the operator of the dry cleaning machine may add soap or water until the desired dry cleaning conditions are obtained. In another form of the device, the soap and moisture are pumped into the dry cleaning machine, each in turn, until the optimum proportions of solvent, soap and moisture are obtained.

It is a very important aspect of the invention that the potential applied to the solvent to determine hindrance thereof may be adjusted in accordance with a calibrated scale to correspond to the temperature of the cleaning fluid. This aspect of the invention is particularly important inasmuch as the most desirable ratios of moisture and soap vary widely with the temperature of the fluid.

The invention, together with further objects, features, and advantages thereof will be more clearly understood by reference to the following detailed specification and claims taken in connection with the accompanying drawings, in which:

Fig. 1 is a schematic representation of apparatus useful in the practice of the invention;

Fig. 2 is a schematic diagram of the electrical circuit of the apparatus of the invention and showing also certain mechanical features thereof;

Fig. 3 is a side view of the connector which may be installed in ordinary commercial dry cleaning machines to enable the practice of the invention;

Fig. 4 is the end view of the connector of Fig. 3; and

Fig. 5 is a schematic representation of a second embodiment of the invention in which automatic control of the condition of the cleaning fluid is accomplished.

Referring now to Fig. 1, there is shown in representative form a dry cleaning machine **10**, an electronic moisture analyzer **11** which is operatively associated with the dry cleaning machine by means of a pick-up **12**, and a cable **13** for connecting the pick-up to the analyzer. The mechanical arrangement of the moisture analyzer **11** with regard to the dry cleaning machine **10** will, of course, vary widely with the particular circumstances of the installation.

The dry cleaning machine **10** may be of any well known type having the usual facilities for washing, extracting and solvent recovery, or appropriate separate facilities for the latter operations.

Referring now to Fig. 2, the apparatus of the invention comprises an electric circuit arrangement including the pick-up **12** which includes a mounting member **14** of insulating material and two electrodes **15** and **16** which extend through the member **14** and project into the interior of the machine. The pick-up **12** is mounted in a wall **17** of the dry cleaning machine so that the electrodes **15** and **16** are immersed in the cleaning fluid within the machine. The electrodes **15** and **16** are, because of the great sensitivity of the mixture analyzer **11**, of relatively small dimensions and need have only a small area of contact with the dry cleaning fluid. In one typical embodiment of the pick-up **14**, the electrodes were 10 millimeters long, 4 millimeters in diameter and spaced 7 millimeters from center-to-center.

The pick-up 14 is connected to the electrical circuit 19 of the analyzer 11 by means of the cable 13 which includes two insulated conductors 20 and 21 and a shielded covering 22. The shielded covering 22 is electrically connected to the dry cleaning machine by any suitable means 23 and to the ground connection 24 of the moisture analyzer 11 for reasons more fully set forth herein.

The moisture analyzer 11 includes a soap indicator comprising a meter 25 having the scale thereof calibrated to indicate the soap concentration both in terms of normal soap and dry soap. This meter also indicates the amount of moisture for a given percentage of soap in the solvent or soap to solvent ratio. A temperature indicator comprising a meter 26 having the scale thereof calibrated in terms of temperature is provided for adjusting the electrical circuit to a condition such that the response of the circuit corresponds to the temperature of the dry cleaning fluid.

The electrical circuit 19 comprises a vacuum tube bridge circuit including two vacuum triodes 27 and 28 which are, for convenience, of the type which are enclosed in a common envelope 29. The vacuum triodes 27 and 28 have characteristics which are well known in the art. Inasmuch as the invention is not limited in the practice thereof to the use of triodes and may comprise, e.g. triodes or pentodes, the expression "electronic discharge devices" will be used in the claims as a generic name therefor.

The bridge circuit includes as one branch thereof the triodes 27, the plate dropping resistor 30 and resistor 32, together with a portion of a balancing potentiometer 34, and, as the remaining branch thereof, the triode 28, plate dropping resistor 31, and resistor 33, together with the remaining portion of the potentiometer 34. The triode 27 and resistor 30, the triode 28 and the resistor 31, the resistor 32 and the resistor 33 constitute separate arms of the bridge.

The bridge is energized by means of a power supply 35 which has the direct current voltage leads 36 and 37 thereof connected to the bridge across the principal diagonal thereof, e.g. to the arm 38 of the potentiometer 34 and to the juncture of the resistors 30 and 31. A resistor 39 connected in series with the positive voltage supply lead 37 serves as a stabilizing and isolating resistor.

The control grid 40 of the triode 28 is maintained at a suitable predetermined bias potential by a bias network which includes a potentiometer 41, a grid resistor 42 and a grid condensor 43. The potentiometer 41 is connected to the negative voltage lead 36 and to the cathode 44 and, together with the resistors 33 and the corresponding portion of the potentiometer 34, produces a voltage drop, so that the arm 45 of the potentiometer 41 is below the potential of the cathode 44 of the triode 28. The bias potential impressed upon the control grid 40 is, therefore, determined by the setting of the arm 45 of the potentiometer 41. The condensor 43 serves to bypass any rapidly changing or transient effects.

The control grid 50 of the triode 27 is connected to an electric circuit which, together with the cable 13, the pick-up 12, the cleaning fluid 18 and the voltage 35, imposes a bias upon that grid which corresponds in magnitude to the condition of the external circuit, e.g. as determined by the condition of the cleaning fluid 18. This circuit includes a biasing network including two resistors 51 and 52 which are connected in series from the grid 50 to the negative voltage lead 36 of the power supply 35. A condensor 53, connected to the control grid 50 and to ground, is of the same capacity as and performs the same function as condensor 43. The conductor 20 of the cable 13 is connected through an isolating resistor 54 to the juncture 55 of resistors 51 and 52 and hence to the control grid 50.

The conductor 21 of the cable 13 is connected through an isolating resistor 55 to a potentiometer 56 which constitutes a part of a bias supply means for applying a bias potential to the control grid 50. The bias supply means comprises a voltage divider 57 which is connected to the voltage supply leads 36 and 37 of the power supply 35 and includes the potentiometer 56, a second potentiometer 58, and a dropping resistor 59. The resistor 59 and the potentiometers 56 and 58 and the resistors 52, 54 and 55 are so proportioned that the grid 50 is at a lower potential than the cathode 61 of the triode 27.

The potential impressed upon the electrode 16 of the pick-up 14, and hence the adjustment of the arm 60 of the potentiometer 56 must be determined with reference to the temperature of the solution 18. The temperature meter 26 which comprises a low current voltmeter is connected to the arm 60 of the potentiometer 56 and to the juncture 62 of the potentiometer 56 with the resistor 59 and is provided with a temperature scale so that the applied voltage is indicated directly in terms of temperature. The scale of the meter is calibrated in degrees of temperature, according to a generally logarithmic scale, inasmuch as the applied voltage changes linearly with the setting of the arm 60 (the potentiometer 56 is a linear potentiometer) while the electrical condition of the fluid changes logarithmically with temperature.

The potentiometer 58 is provided so that the manner in which the voltage changes with change in position of the arm 60 may be at will. Such adjustments may be necessary upon initial calibration of the analyzer or when the solution 18 is itself changed, for example, to use different additives, so that the reading of the soap indicator meter 25 will correspond to the actual condition of the solution. In practice, the analyzer must be calibrated for the particular soap being used, and this is accomplished by adjusting the potentiometer 58.

The various potentiometers are mounted so as to be adjustable from the front panel of the analyzer 11 during the operation of the device. Thus, the potentiometer 56 is mounted below the associated temperature indicator meter 26 and with a knob 63 to permit adjustment of the arm 60 in accordance with the temperature of the cleaning fluid. The potentiometer 34 is mounted on the front panel and is provided with a knob 64 so as to permit an initial adjustment of the circuit 19 as indicated by the soap indicator meter 25. The potentiometer 58 is mounted on the front panel and is provided with a knob 65 to permit calibration of the meter 25 and the potentiometer 56 for different temperatures. Although not so shown in Fig. 1, the potentiometer 41 may also be mounted on the front panel so as to permit changes in the operating point of the triodes 27 and 28 during the ordinary use of the instrument, to adjust the device for use with various types of solutions. The potentiometer 41 may comprise a rotary tap switch, as is shown in the arrangement of Fig. 5.

The power supply 35 comprises a power transformer 66 having a primary 67 thereof adapted to be connected to an alternating current supply through a line switch 68. The secondary winding 69 of the transformer constitutes a high voltage winding for supplying suitable high voltages to a rectifier 70. The pulsating direct current from the rectifier 70 is filtered by a condensor 71 which cooperates with the voltage divider 57 and an isolating resistor 72.

I have found that, in the practice of the invention, it is very important that the electrical apparatus including the analyzer 11, the pick-up 12 and the cable 13 be completely shielded in order to eliminate the effects of stray capacities. To this end, the analyzer 11 is incorporated in a housing of sheet metal, while the cable 13 includes a woven metallic sheath on the outside thereof. The pick-up 12 electrically connects the analyzer, the cable shield and the dry cleaning machine and is shown in detail in Figs. 3 and 4. As thereshown, the pick-up 12 comprises the two electrodes 15 and 16 which are embedded in and supported by a member 80 of insulating material. The

member 80 is of generally circular cross section and is incorporated in a metallic body member 81 which includes a flange portion 82 having openings 83 for securing the member to the wall of the dry cleaning machine 10 in conductive engagement therewith.

A connector 84 is attached to the end of the cable 13 and comprises a cylindrical body member 85 having an internally threaded portion 86 adapted to engage a similar part 87 of the member 81. The body member 85 is formed of metal and carries an insulating member 88 which, in turn, carries two contacts 89 and 90 which are held in position against the outer ends of the electrode members 15 and 16. The conductors 91 and 92 of the cable 13 are soldered to the contacts 89 and 90 and correspond to the conductors 20 and 21 of Fig. 2. The sheath 93 is received in a member 94 which is clamped in place and firmly engaged by the body member 85 so as to form an adequate electrical contact with the sheath.

While the particular shape of the electrodes is not critical, still it is to be emphasized that it is an important feature of the invention that the probes are of very small physical dimensions. The great sensitivity of the bridge circuit of Fig. 2 enables the use of electrodes of such small size and the advantages of their use will be apparent to those skilled in the art. In the application of the invention to other purposes, e.g. in laboratories and other analysis work, I contemplate the use of flat electrodes, e.g. 10 millimeters long, 5 millimeters wide and spaced 5 millimeters apart in order to provide a standard reference area which may serve as a basis for subsequent calculations.

In practicing my invention, I fill the dry cleaning machine with a predetermined amount of solvent liquid, either synthetic solvent such as perchlorethylene or a petroleum base solvent. With the moisture indicator 11 properly connected to the pick-up 12 by means of the cable 13 and properly supplied with alternating current, I adjust the knob 63 so that the temperature indicator meter displays a reading corresponding to the temperature of the solvent. I then adjust the knob 64 so that the needle of the indicator meter 25 indicates a zero reading. This adjustment of the knob 64 varies the potentiometer arm 38 so as to bring the bridge to a balance condition, as indicated by the zero reading in the meter, and thereby eliminates the effect of the conductivity of the solvent itself upon the subsequent readings. I then add soap to the solvent while agitating the drum until the meter 25 indicates that a 4% solution has been reached. This determination must, of course, be made upon the normal soap scale of the meter 25.

For the purposes of calibrating the analyzer, the initial soap percentage must be determined either by quantitive measure or by titration. When the percentage is determined, the potentiometer 58 is adjusted by knob 65 to indicate the corresponding percentage on the scale of meter 25. The indicator is thus calibrated to give correct percentage reading for this particular brand or type of soap.

Inasmuch as the soap added to the solvent carries a significant amount of moisture, it is necessary in order to insure the accuracy of the subsequent readings to obtain a calibration in terms of percentage of dry soap. I accomplish this calibration by placing a number of garments which have been thoroughly dried into the drum of the dry cleaning machine and, after running the machine for a short period of time, observe the reading on the meter 25 on the dry soap scale thereof. The dry garments tend to absorb the moisture introduced into the solution by the soap so that the moisture plays no effective part in determining the electrical condition of the solvent soap solution. The effect may be observed by watching the needle of the meter 23 drop back to a low reading shortly after the dry garments are put into the machine and the machine started.

Having thus obtained a direct measure of the soap in the initial solution, it then becomes feasible to determine the exact amount of moisture which must be added for optimum dry cleaning of any given type of garment. Inasmuch as suitable charts are available whereby the optimum quantities of moisture useful in dry cleaning the various types of fabrics for any given soap concentration and at the various temperatures of the solution, it is necessary only that that optimum quantity be determined and to introduce moisture into the solvent soap mixture in relatively small amounts until the meter 25 indicates a proper percentage of moisture in the resulting solution as measured along the dry soap scale. The moisture is, of course, added after the garments have been introduced into the machine, and while the machine is in operation, so as to accommodate the tendency of dry garments to absorb substantial quantities of moisture. Care must be taken, of course, where the garments carry a substantial amount of moisture, and, if excessive, a preliminary drying may be necessary in order not to initially carry an excess of moisture into the solution.

Having determined the optimum amount of moisture necessary for the particular cleaning operation and having obtained that proportion of moisture in the cleaning fluid, the cleaning operation may then proceed as desired with the meter 25 providing a continuous indication of the manner in which the ratio of moisture to soap and solvent changes throughout the cleaning operation. It will normally be found that, while the cleaning operation may be initiated with the exact ratio of moisture to soap and solvent desired, but after the operation has proceeded for several minutes, that the needle of the meter 25 will slowly drop back to a much lower reading. Inasmuch as the efficiency of the cleaning operation is greatly reduced under these circumstances, the advantages of the present invention will be readily apparent inasmuch as it is only necessary to add a further small amount of moisture to obtain the optimum proportions of moisture in the solution.

After each load of garments is cleaned, the fluid is drained from the tub of the dry cleaning machine and the cleaning fluid carried by the garments is extracted by spinning the drum of the machine. The solvent recovered from the garments during the extracting process is distilled so that the soap in that portion of the cleaning fluid is lost. In order to maintain the proper component proportions in the cleaning fluid within reasonable limits, I find it desirable to add a stock solution comprising about 25% solvent, 50% moisture and 25% normal soap solution. Such a stock solution has been found to maintain the overall amount of the cleaning fluid in the machine while reasonably maintaining the proportions of moisture to soap and solvent, within limits of variation adequate to insure highly accurate indications by the meter 25.

Referring now to Fig. 5, there is shown an embodiment of the invention which is adapted to automatically maintain the proportions of soap and moisture in the dry cleaning machine in response to the measurements brought about by the operation of an electrical bridge circuit corresponding to that shown in Fig. 2. The circuit is such that unbalance of the bridge, such as is indicated by the meter 25 in Fig. 2, causes predetermined quantities of soap and water to be injected into the cleaning machine at predetermined successive intervals of time. More particularly, the apparatus 100 includes an electrical bridge and associated circuits 101, an electrical control apparatus 102, a soap pump 103, a moisture pump 104, a soap control 105 and a moisture control 106.

The electrical bridge 107 comprises a vacuum tube 108 having two triode sections 109 and 110. Resistors 111 and 112 in the plate circuit of the triodes and resistors 113 and 114 in the cathode circuits thereof constitute parallel arms of the bridge. A balancing potentiometer 115 in the parallel arms functions in the same manner as the corresponding arrangement of Fig. 2.

The soap control 105 comprises a tap switch 116 and

fixed resistors 117, 118, 119 and 120 connected between the successive taps thereof and corresponding in function to the potentiometer 41 of Fig. 2. A soap indicator meter 122 is connected in the subsidiary diagonal of the bridge 107 and corresponds in function to the meter 25 of Fig. 2.

The temperature control includes two potentiometers 123 and 124, a temperature indicator meter 125 and a calibrating potentiometer 126, all comprising a part of a voltage divider 127 for a power supply 128 and similar to the arrangement of Fig. 2. The circuit 101 is connected to the pick-up 12 by means of a cable which is connected to an outlet 129.

The soap pump 103 and the moisture pump 104 are electrically energized pumps, each adapted to deliver quantities of fluid which are in direct proportion to the length of time which the pump is running. The pumps are energized from the portion of the power supply 128 including a low voltage winding 130, two half-wave rectifiers 131 and 132 and a filter comprising a choke 133 and a condensor 134. The negative terminal of the low voltage supply is grounded at 135.

The operation of the pumps 103 and 104 is controlled by a relay 136 which has the coil 137 thereof connected in a series circuit across the arms of the bridge between the anodes of the triodes 109 and 110. The circuit includes the relay 136, contacts 138, 139 and 140 of a relay 141 and the moisture control 106.

The moisture control 106 comprises a tap switch 142 having resistors 143, 144, 145, 146 and 147 connected between the successive taps of the switch. A potentiometer 148 serves as a means for calibrating the moisture control circuit.

The series circuit which includes the moisture control 106 and the relay 136 is so arranged that, when the bridge becomes unbalanced due to an insufficiency of soap or moisture in the cleaning solution, the relay 136 is operated to energize either the soap pump 103 or the moisture pump 104. The operation of those pumps is accomplished by two contacts 149 and 150 of the relay 136 and two relays 151 and 152 which cause the soap pump and the moisture pump to be successively operated for predetermined intervals of time in order to maintain the proper ratio of soap to moisture in the fluids which are added to the fluid of the machine.

The relay 151 is operated by a start switch 153 which is adapted to energize the solenoid 154 of the relay from the positive lead 155 of the low voltage supply 156 through a series circuit which includes a pair of normally closed contacts 157 and 158 of the relay 152. A holding circuit includes the contacts 159 and 160 which serve to maintain the solenoid 154 in an energized condition after the start button 153 is released.

The contact 161 of relay 151 is connected to the contact 150 of relay 136 while an associated normally open contact 162 is connected to the heater element 163 of a time delay relay 164. When, therefore, the contacts 149 and 150 of relay 136 are closed by an unbalanced condition of the bridge while the relay 151 is operated, a low voltage circuit through the element 163 is completed so that the contacts 165 are closed after a predetermined period of time. The contacts 165 are connected in a series circuit which includes the positive lead 155 of the low voltage power supply, the soap pump 103 and a ground return to the negative terminal of the lower voltage power supply so that the soap pump 103 is energized. A second normally closed contact 161 of relay 151 is connected to a contact 167 of relay 152 which is also a normally open contact. If, therefore, contacts 149 and 150 of relay 136 are closed while relays 151 and 152 are in an unenergized condition, the operation of the pumps 103 and 104 is unaffected.

The start button 153 is connected to the heater element 168 of a time delay relay 169 so as to energize that heater element from the positive lead 155 of the low voltage supply when the start switch is closed. The heater element is then maintained in an energized condition through the contacts 159 and 160 of relay 151 so long as that relay is in an energized condition. The contacts 170 of the relay 169 are connected from the positive lead 155 to the solenoid 171 of relay 152 through normally closed contacts 172 and 173 of the relay. The solenoid 171 of the relay 152 is, therefore, energized to operate the relay upon the elapse of a predetermined interval after the start button 153 is closed. Upon operation of the relay 152, the contacts 157 and 158 are opened to deenergize relay 151 and thereby stop the pump 103, deenergize the relay 169 and connect the moisture control 106 in series with the coil 137 of relay 136.

The normally open contact 167 of relay 152 is connected to the normally closed contact 166 of relay 151 so that, upon operation of relay 152 when relay 151 is in an unoperated condition, the solenoid 171 of relay 152 is energized from the positive lead 155 through the contacts 149 and 150 of relay 136, while contacts 167 and 173 effectively form a holding circuit for the relay 152. A contact 174 of the relay 152 is connected to the contacts 166 and 167 and has associated therewith a normally open contact 175 which is connected to the heater element 176 of a time delay relay 177. Upon operation of the relay 152, the heater element 176 is energized from the positive lead 155 and, after the elapse of a predetermined interval of time, the contacts 178 are closed to complete a circuit which includes the positive lead 155 of the low voltage power supply, the moisture pump 104 and the negative lead 135 of the power supply. The operation of the moisture pump 104 continues so long as the contacts 149 and 150 are in a closed condition. When the cleaning fluid has received a sufficient amount of moisture so that the bridge is brought back to a balanced or substantially balanced condition, contacts 149 and 150 are opened, the relay 152 is deenergized and contacts 157 and 158 are closed, thus preparing the apparatus for a succeeding cycle of operation. If, for any reason, an excessive amount of soap or moisture is added to the cleaning fluid, the resulting unbalance of the bridge circuit 107 in the opposite direction will cause the contacts 149 and 180 to close and complete the circuit to an alarm 181.

The relay 136 is a relatively sensitive relay of the order of 50 microamperes and adapted to open and close the contacts 149 and 150 upon a current change of a few microamperes. The extent of unbalance of the bridge is such that a larger amount, e.g. 100 microamperes is required to produce a mid-scale reading of the meter 122. The variable resistor 142 of the moisture control 106 is, therefore, required to calibrate the series circuit so that the relay 136 will be operated about either reference condition of unbalance, e.g. dry soap solution or normal solution.

In operating the apparatus of Fig. 5, I prepare a solution comprising the usual solvent and then add a sufficient amount of soap to produce a pretermined 4% of normal solution, e.g. a solution including the moisture carried by the soap. With the soap control 105 set at position 4 which corresponds to a 4% normal solution, I then adjust the calibrating potentiometer 126 until the meter 122 reads at mid-scale. The temperature control is, of course, set to a position so that the meter 125 reads a temperature corresponding to the temperature of this solution.

A sufficient number of dry garments are then placed in the tub of the machine and the machine is started. The needle of the meter 122 then moves to the left to indicate a 4% dry solution as the garments absorb the moisture carried into the solution by the soap and the circuit of the relay 136 may be calibrated by closing the contacts 138 and 139 and adjusting the potentiometer 148 so that the contacts 149 and 150 of the relay 136 open at the 4% dry reading of the meter, but close for any lesser reading, e.g. any greater deflection from the mid-point position.

The operation of the apparatus is then initiated by actuating the start button **153** whereupon the relay **151** is operated and the pump **103** is energized to pump soap into the dry cleaning machine. The soap is pumped until such time as a 4% dry soap solution is reached at which time the contacts **149** and **150** are operated, thus deenergizing the relay **151** and stopping the pump **103**. At the expiration of the interval determined by the time delay relay **169**, the relay **152** is operated to deenergize the relay **151**, whereupon relay **152** is energized and the moisture pump **104** is started by the relay **177** upon closure of contacts **174** and **175**. The moisture pump continues to operate until such time as the cleaning fluid is brought to the condition of relative humidity as determined by the setting of the control **106**, and the bridge is again balanced so as to open the contacts of the relay **136** and deenergize relay **171**.

The moisture control **106** is connected in the circuit of the relay **136** during the operation of the moisture pump **104** so that the relay **136** is not operated while pumping moisture until such time as the balanced condition exists. The resistors **143**, **144**, **145**, **146** and **147** are of suitable size for determining the various amounts of moisture or degree of humidity desired. The actual setting employed will, of course, depend on the kind of garments employed. For example, position **2** may correspond to white garments; position **3**, to silk garments; position **4**, to wool garments; and position **5**, to raincoats.

The operation of the apparatus is initiated by closing the button **153** for each succeeding load. The apparatus functions to maintain the proper proportions of soap and moisture within narrow limits and needs to be adjusted only for the different types of articles to be cleaned.

It is to be understood that the specific terminology of the present disclosure is not intended to be restrictive or confining and that various rearrangements of parts and modifications of design may be resorted to without departing from the scope or spirit of the invention as herein claimed.

What is claimed is:

1. Dry cleaning apparatus comprising the combination of a dry cleaning machine, and a pick-up mounted on the said machine and having two relatively small electrodes adapted to be contacted by the cleaning fluid in the machine, an electrical moisture analyzer and electrical conductors connecting said moisture analyzer with the said pick-up, said analyzer comprising electrical circuit means including means for balancing out the effect of the solvent of the cleaning fluid, means for determining the electrical condition of the fluid after the effect of the solvent has been balanced out, and means for modifying the response of the said circuit means in accordance with the temperature of the cleaning fluid.

2. Dry cleaning apparatus comprising the combination of a dry cleaning machine, a pick-up mounted on the said machine having two relatively small electrodes adapted to be contacted by cleaning fluid in the machine, an electrical moisture analyzer enclosed in a shielded cabinet, and a shielded cable connecting said moisture analyzer with the said pick-up and the cabinet of the analyzer with the housing of the machine, the said analyzer comprising electrical circuit means including means for balancing out the effect of the solvent of the cleaning fluid, means for determining the electrical condition of the fluid after the effect of the solvent has been balanced out and means for modifying the response of the said circuit means in accordance with the temperature of the cleaning fluid.

3. Dry cleaning apparatus comprising the combination of a dry cleaning machine, a pick-up mounted on the said machine and having two relatively small electrodes adapted to be contacted by cleaning fluid in the machine, an electrical moisture analyzer enclosed in a shielded cabinet, and a shielded cable connecting said moisture analyzer with the said pick-up and the cabinet of the analyzer with the housing of the dry cleaning machine, the said analyzer comprising electrical circuit means including an electrical bridge having one arm thereof connected to one of the said electrodes and controlled thereby, a meter connected in the subsidiary diagonal of the bridge for indicating unbalance thereof and a potentiometer for balancing out the effect of the solvent of the cleaning fluid, means for applying a bias voltage to the remaining one of the electrodes and a meter for indicating the amount of the bias, and means for adjusting the said bias voltage to set the said temperature indicator to a temperature corresponding to that of the cleaning fluid.

4. Apparatus for determining the electrical properties of a solution which comprises the combination of a pick-up having two spaced electrodes adapted to be immersed in the solution and an electrical measuring device comprising a balanced electrical bridge having an electronic discharge device in each of two parallel branches thereof, voltage supply means connected across the principal diagonal of the bridge with the positive terminal thereof connected to the anodes of the said discharge devices and the negative terminal thereof to the cathodes of the said discharge devices, a first potentiometer connected in the said two branches of the bridge and the arm thereof connected to the power supply for balancing the bridge, a bias network comprising a second potentiometer connected from the arm of the first potentiometer to the cathode of one of the said discharge devices and a grid resistor connected from the arm of the said second potentiometer to the control grid of the first discharge device for adjustably determining the bias voltage on the said control grid, a second biasing network connected to the arm of the said first potentiometer and the control grid of the second one of the said discharge devices and to one of the said pick-up electrodes, bias supply means comprising a voltage divider connected across the said power supply and including a first bias potentiometer having the arm thereof connected to the remaining one of the pick-up electrodes for applying a predetermined bias voltage to that electrode and a meter connected to the arm of the said first bias potentiometer and a voltage tap on the said divider, and having a scale calibrated in temperature so that the bias voltage may be adjusted directly to correspond to an auxiliary temperature reading, and an indicator comprising a meter connected to the two cathodes of the said discharge devices for determining the overall condition of the solution from the unbalance of the bridge shown by the indicator.

5. Apparatus for determining the proportion of moisture in a dry cleaning fluid including soap and solvent which comprises the combination of a pick-up adapted to be mounted in a dry cleaning machine, the said pick-up including two spaced electrodes adapted to be contacted by the cleaning fluid, a cable having two conductors connected to the electrodes of said pick-up, and an electrical measuring device connected to the remote end of the said cable and comprising an electrical bridge having an electronic discharge device in each of two parallel branches thereof, voltage supply means connected to the principal diagonal of the bridge formed by the said parallel branches, an indicating device comprising a meter connected in the remaining diagonal of the said bridge, the said meter having a scale calibrated to read soap and moisture concentrations, means for applying an adjustably predetermined bias voltage to a control grid of a first one of said discharge devices, a connection between the control grid of the remaining discharge device and an electrode of said pick-up including one of the said two conductors of the cable, means for applying an adjustably predetermined bias voltage to the remaining one of said pick-up electrodes, a connection between the said bias voltage supply means to the said electrode including the remaining one of the said two conductors, indicating means connected to said last-named supply means includ-

ing a meter having a scale graduated in temperature whereby the voltage applied to the electrode may be set in accordance with the temperature of the fluid, and means for balancing out the effect of the conductivity of the solvent of the dry cleaning fluid comprising a potentiometer connected in the said two branches of the bridge and having the arm thereof connected to the said power supply.

6. Apparatus for determining the proportion of moisture in dry cleaning fluid including soap and solvent which comprises the combination of a pick-up adapted to be mounted in a dry cleaning machine and including two spaced electrodes adapted to be contacted by the cleaning fluid, a cable having two conductors connected to the electrodes of the said pick-up and a shield conductor adapted to be connected to the dry cleaning machine, and an electrical measuring device connected to the remote end of said cable comprising the electrical bridge having an electronic discharge device in each of two parallel branches thereof, voltage supply means connected to the principal diagonal of the bridge formed by the said parallel branches, an indicating device comprising a meter connected in the remaining diagonal of the said bridge, the said meter having a scale calibrated to read soap and moisture concentrations, means for applying a predetermined bias voltage to the control grid of one of the said discharge devices, a connection between the control grid of the remaining discharge device and an electrode of said pick-up including one of the said two conductors of the cable, means for applying a bias voltage to the remaining one of the said pick-up electrodes, and means for adjusting the said bias voltage, a connection between the said bias voltage supply means and the said electrode including the remaining one of the said two conductors, an indicating device connected to the last-named supply means including a meter having a scale graduated in temperature whereby the voltage applied to the electrode may be set in accordance with the temperature of the fluid, means for balancing out the effect of the conductivity of the solvent of the dry cleaning fluid comprising a potentiometer connected in the said two branches of the bridge and having the arm thereof connected to the said power supply, and a shield enclosing the said electrical measuring device and connected to the said shield conductor of the cable for shielding the entire apparatus against the effect of stray capacity effects.

7. Apparatus adapted to be utilized with a dry cleaning machine including a pick-up having two relatively small electrodes adapted to be mounted in the machine and be contacted by cleaning fluid therein, an electrical moisture analyzer enclosed in a shielded cabinet and a shielded cable connecting said moisture analyzer with the said pick-up, the said analyzer comprising circuit means including an electrical bridge for balancing out the effect of the initial normal solution of cleaning fluid, means for determining the electrical condition of the cleaning fluid after the effect of the normal solution has been balanced out, and means for modifying the response of the said circuit means in accordance with the temperature of the cleaning fluid, an electrical moisture pump adapted to be connected to the cleaning machine and to a water tank, and electric circuit means connected to the said moisture analyzer and to the said pump for operating the said pump in response to an unbalance condition of the bridge.

8. Apparatus adapted to be utilized with a dry cleaning machine including a pick-up having two relatively small electrodes adapted to be mounted in the machine and be contacted by cleaning fluid therein, an electrical moisture analyzer enclosed in a shielded cabinet and a shielded cable connecting said moisture analyzer with the said pick-up, the said analyzer comprising electric circuit means including an electrical bridge for balancing out the effect of the initial normal solution of cleaning fluid, means for determining the electrical condition of the cleaning fluid after the effect of the normal solution has been balanced out, and means for modifying the response of the said circuit means in accordance with the temperature of the cleaning fluid, an electrical soap pump adapted to be connected to the cleaning machine and to a soap tank, an electrical moisture pump adapted to be connected to the cleaning machine and to a water tank, and electric circuit means connected to the said moisture analyzer and to the said pumps for operating the said pumps in a predetermined order in response to unbalance conditions of the bridge.

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