

Aug. 20, 1963

M. B. MATHEWS

3,101,240

DRY CLEANING

Filed June 29, 1953

3 Sheets-Sheet 1

Fig. 1.

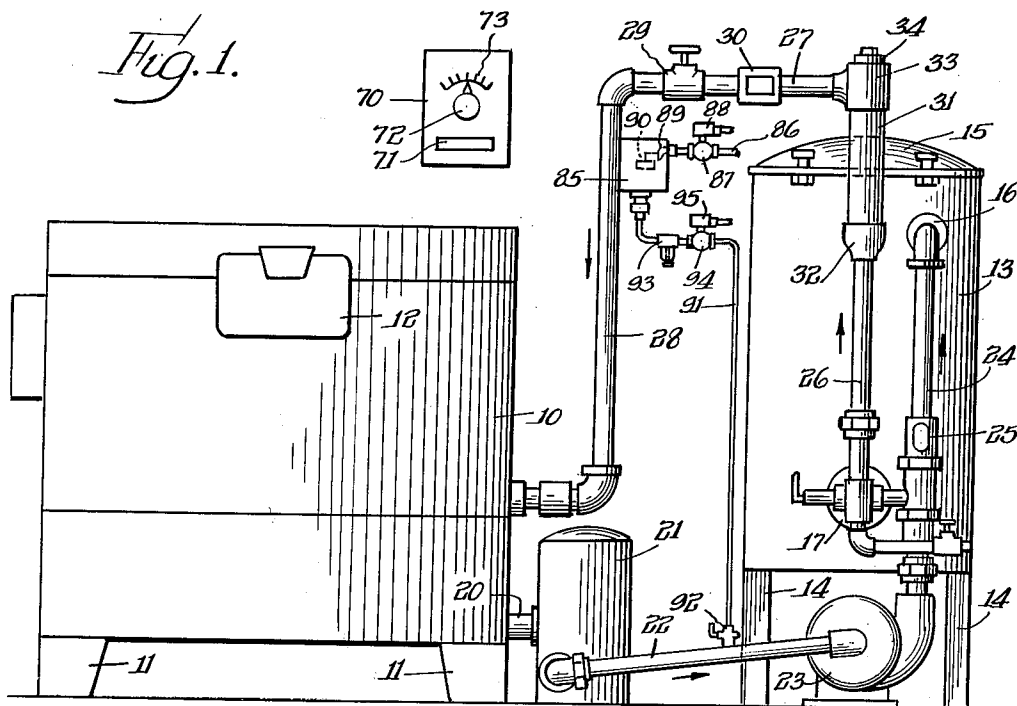
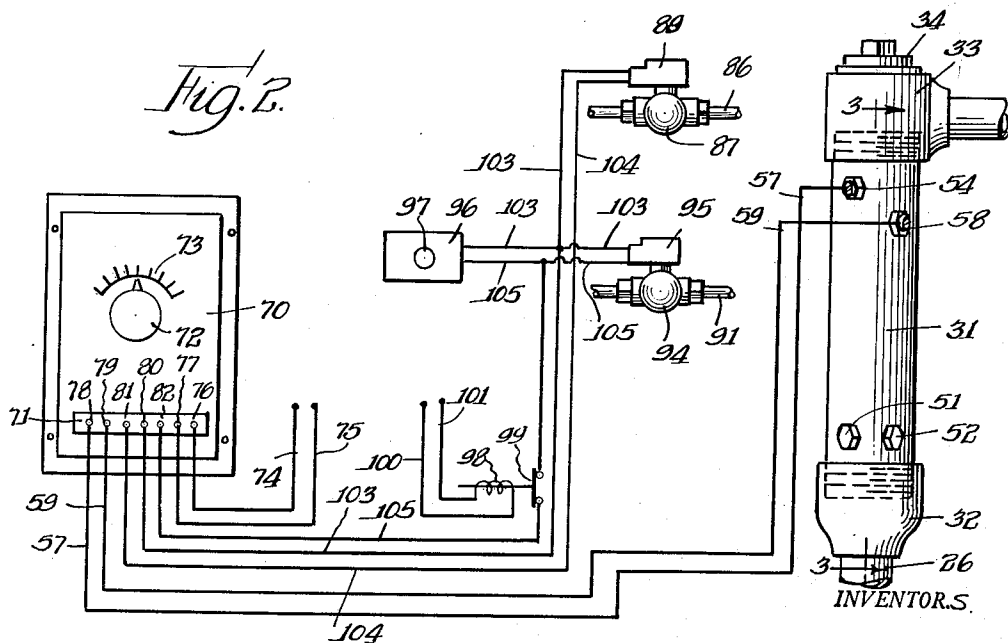


Fig. 2.



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3 Sheets-Sheet 2

Fig. 3.

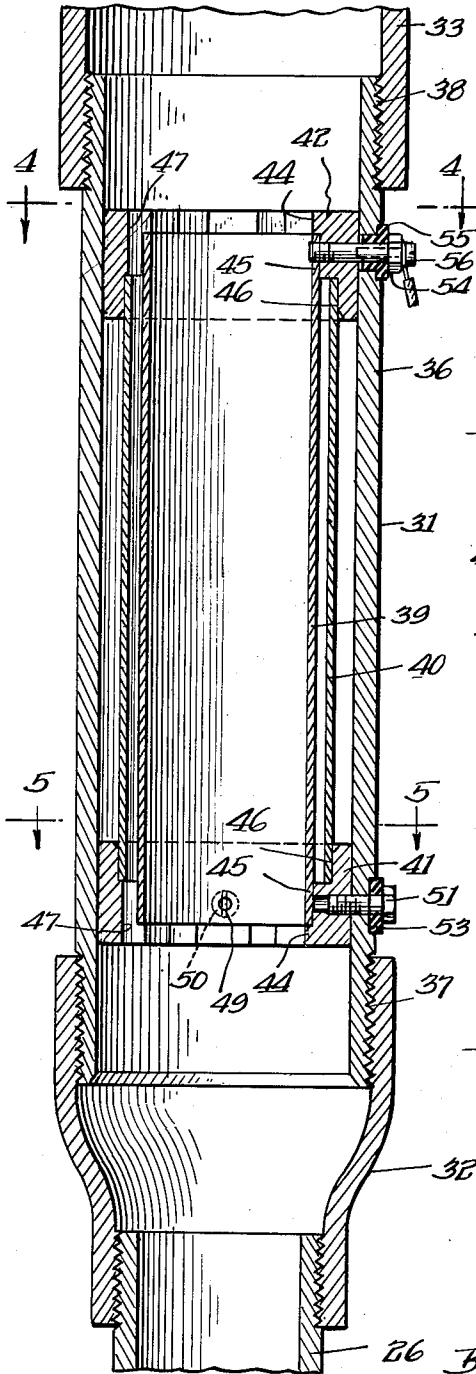


Fig. 4.

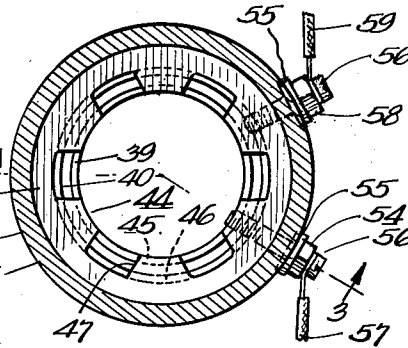


Fig. 5.

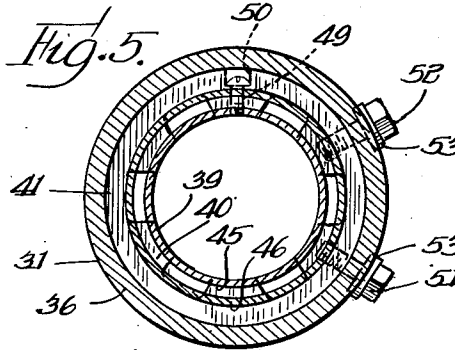


Fig. 6.

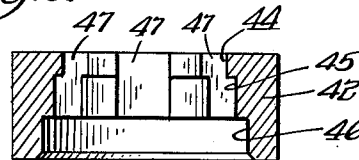
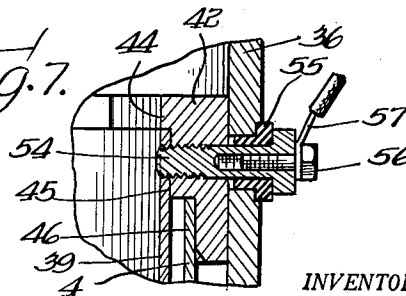


Fig. 7.



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DRY CLEANING

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3 Sheets-Sheet 3

Fig. 8.

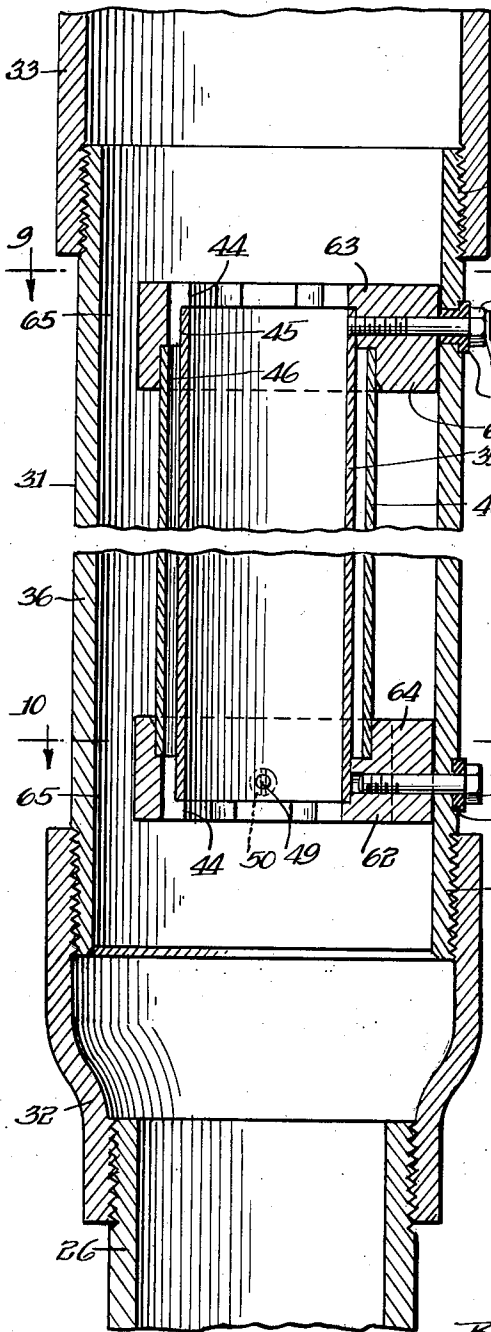


Fig. 9.

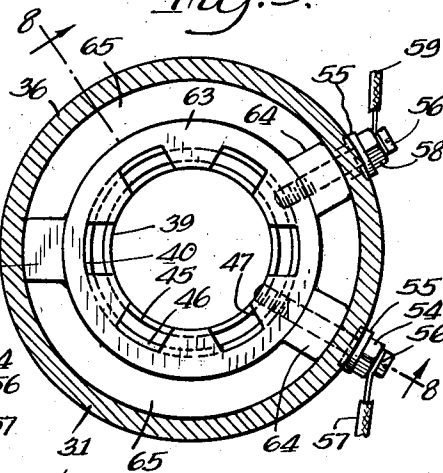


Fig. 10.

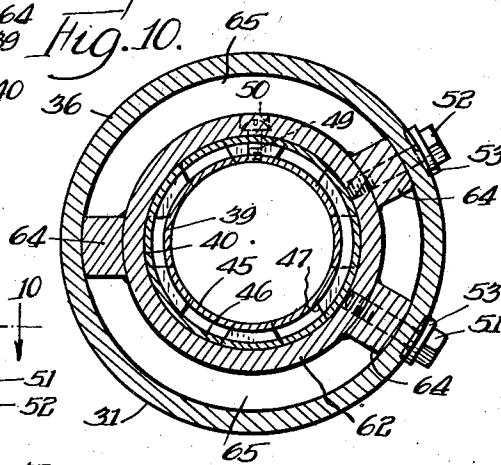
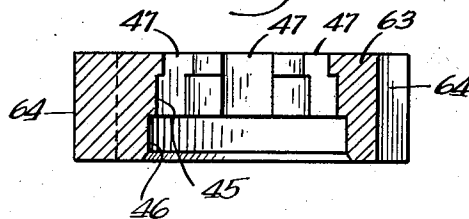


Fig. 11.



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3,101,240

## DRY CLEANING

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8 Claims. (Cl. 8-142)

My invention relates to the art of dry cleaning of fabrics. It is particularly concerned with methods to insure maintenance of high cleaning efficiency of the dry cleaning solvent in a simple and effective manner.

In the usual process of dry cleaning fabrics, the soiled fabrics are subjected to the action of a volatile organic solvent which is immiscible with water as, for example, naphtha, Stoddard solvent, carbon tetrachloride, gasoline, benzene, trichlorethylene, and the like. Such solvents are effective for the removal of grease or oil stains as well as dust, dirt, lint and the like which commonly adhere to the grease and oil. It is conventional practice, in order to effect the removal of water-soluble stains, such as those caused by various foods and the like, to introduce into the volatile organic solvent in the washer a small proportion of water, usually of the order of 0.05%. This is commonly done by utilizing, in conjunction with the dry cleaning organic solvent, a small proportion of an oil-soluble dispersing agent which may, for example, be an oil-soluble higher fatty acid soap or other type of anionic, cationic or nonionic dispersing agent but is very commonly an oil-soluble synthetic organic detergent as, for example, long chain petroleum sulfonates such as the mahogany sulfonates; sulfated fatty alcohols, such as lauryl sulfate; long chain sulfoacetates, such as lauryl sulfoacetate; long chain alkyl sulfosuccinates such as dioctylsodiumsulfosuccinate; higher fatty acid monoglycerides such as mono-olein; higher fatty acid monoglyceride sulfates, such as mono-olein mono-sulfates; and the like, the sulfates and sulfonates being used in the form of salts. In the presence of such dispersing agents, the water added to the dry cleaning volatile organic solvent is very finely or colloiddally dispersed throughout the solvent so as to form what is apparently, to the naked eye, a homogeneous "solution" or what may be characterized as a pseudo solution. While the advantages of the addition of water to a water-immiscible dry cleaning organic solvent and the "solubilizing" of the water by means of an oil-soluble dispersing agent have been, broadly speaking, heretofore known and used, the full potentialities of such existing knowledge have not been utilized in practice because of the failure to understand certain aspects of the criteria which govern the conditions under which the dry cleaning operation is best practiced. Thus, for instance, as almost invariably practiced today, the amount of water added to the water-immiscible dry cleaning solvent is based upon the weight and nature or condition of the fabrics added to the washer, a situation which is affected, among other things, by the relative humidity in the atmosphere and by other factors. The real key to the matter of insuring uniform superior dry cleaning in modern reclamation systems lies in the discovery of the relationship and significance of electrical conductivity and the control and maintenance of the conditions which account for certain minimum electrical conductivity essential for the securing of the aforesaid results.

In the dry cleaning operation proper, utilizing such substantially clear homogeneous "solutions," when the soiled fabrics are contacted with the dry cleaning "solution" in the so-called washer or wheel, the fabrics absorb a certain amount of such water from the dry cleaning "solution," the amount of such absorbed water depending upon the nature and condition of the fabrics. The remaining moisture in the dry cleaning organic solvent "solution" remains more or less constant during the

2

cleaning operation of that particular batch of clothes. However, when a new batch of clothes or fabrics is introduced into the washer and is contacted with such dry cleaning organic solvent "solution," an additional amount of the water dispersed therein is abstracted or absorbed by the clothes or fabrics. The result is that in the dry cleaning operations conducted by any plant the moisture content of the volatile organic solvent "solution" varies quite considerably from batch to batch of soiled fabrics and, at various stages of the use thereof for the cleaning of different batches of clothes or fabrics, the moisture content drops to a point where it is inadequate to serve its intended purposes, and the cleaning results are nonuniform.

In the dry cleaning step proper, as carried out in the so-called washer or wheel, it has been the practice to utilize various concentrations of oil-soluble soaps or detergents as, for example, from a small fraction of one percent to as high as seven percent or even higher. During the cleaning of various batches of clothes, the concentration of the soap or detergent decreases and it has, therefore, been the practice to replenish the soap or detergent content from time to time.

Despite all of such prior knowledge and practices, serious difficulties and lack of significant knowledge have existed so that, from a practical standpoint, it has not been possible for the operator of a dry cleaning establishment to carry out the dry cleaning operations in such a manner as to obtain uniform substantially optimum results from batch to batch of fabrics being cleaned.

It has been discovered that outstandingly satisfactory uniform cleaning results of high efficiency can be obtained in a simple, safe and practical manner by procedure which may readily be understood and practiced by the average operator of a dry cleaning establishment. This invention is based, in part, on the discovery that, in dry cleaning with water-immiscible organic solvent "solutions" containing an oil-soluble dispersing agent or dry cleaning soap or detergent and water, as more particularly described below, the electrical conductivity of such "solutions" should be maintained at not less than about  $10 \times 10^{-7}$  mhos to insure uniformly superior overall results with respect to removal of inert soil, water-soluble soil, prevention of soil redeposition, whiteness retention, avoidance of deleterious action on fabrics, economy of detergent consumption, and freedom from interference with proper operation of the filtration and distillation systems. The amount and type of dry cleaning dispersing agent or detergent and the amount of water influence the degree of electrical conductivity imparted to the dry cleaning water-immiscible organic solvent. However, the state of distribution of the water is also a very important factor. In all cases, for the effective practice of this invention, the water must be so finely or colloiddally dispersed in the organic solvent as to produce a substantially clear homogeneous "solution," so far as the naked eye is concerned, or what may be characterized as a pseudo solution. In this connection, it may be noted that it is entirely possible to provide mixtures of water-immiscible organic solvents and oil-soluble dispersing agents and water, identical in proportions such as have been found to be especially effective as hereafter described, and still be unsatisfactory for purposes of this invention because their electrical conductivity falls appreciably below the aforesaid value of  $10 \times 10^{-7}$  mhos due to the fact that the water is not properly distributed through the organic solvent. Hence, it will be understood that when I speak herein of "solutions" containing oil-soluble dispersing agents or detergents and water, it will be understood that I mean such "solutions" wherein the water is so finely dispersed as to form a substantially clear homogeneous "solution" in the water-immiscible organic solvent, as viewed by the naked

eye. It is also important, for the most effective practice of this invention, that the entire system be charged with water so that the "solubilized" water passes through the filter.

This invention is also based, in part, on a procedure involving periodically determining the electrical conductivity of the aforesaid dry cleaning "solutions" and, if, during use of such "solutions" in the cleaning of a batch or successive batches of soiled fabrics, the electrical conductivity has dropped to appreciably below  $10 \times 10^{-7}$  mhos an amount of water and/or oil-soluble dispersing agent or dry cleaning detergent is added to the "solution" so as to bring the electrical conductivity thereof to not less than the aforesaid minimum value thereof.

This invention is particularly advantageously practiced with the utilization, as the oil-soluble dispersing agent, of sulfate and sulfonate detergents containing an alkyl group of at least 8 carbon atoms and usually between 8 and 18 carbon atoms, in the form of salts thereof as, for instance, the alkali metal, ammonium and amine salts. In addition to the examples thereof described above, salts of higher alkyl aryl sulfonates such as dodecyl benzene sulfonate, octyl benzene sulfonate, nonyl naphthalene sulfonate, keryl benzene sulfonates, and the like can be utilized. It is also particularly advantageous, in the especially preferred embodiments of this invention, to utilize proportions of oil-soluble dispersing agent or detergent, on the non-volatile basis, of not less than about 1.5%, based on the volume of the organic solvent, and desirably within the range of about 1.5% to about 3%, a good average being about 2%. In this connection, it will be understood that dry cleaning detergents are commonly marketed in the form of liquid or paste products and frequently contain diluents, volatile ingredients and the like over and above the non-volatile dry cleaning detergents proper. When I speak of, for example, 1.5% to 3% of the dry cleaning detergent, said percentages are in the non-volatile active detergent basis.

The amount of water added to the water-immiscible dry cleaning solvent should, in the particularly preferred embodiments of this invention, not be appreciably less than 0.2%, by volume, and most desirably ranges from about 0.2% to about 0.4%, it being relatively uncommon that this latter figure will be exceeded. So far as actual cleaning practice goes, these amounts of water are abnormally large but their use, under the conditions of the present invention, has been found to be most advantageous, cleaning of the fabrics being enhanced and subsequent spotting operations being reduced to a substantial minimum.

The optimum conditions under which the dry cleaning operation should be conducted, taking into account the over-all aspects, therefore, will, in general, involve the utilization of a water-immiscible dry cleaning organic solvent "solution" containing from about 1.5% to about 3%, with a good average of about 2%, of an oil-soluble sulfate or sulfonate detergent containing an alkyl group of at least 8 carbon atoms, and from about 0.2% to about 0.4%, with a good average of about 0.3%, of water, the electrical conductivity of said "solution" being not less than about  $10 \times 10^{-7}$  mhos.

In the light of the foregoing description, it will be understood that, in the case of the foregoing dry cleaning organic solvent "solutions," the electrical conductivity varies more or less uniformly as a function of the water and detergent content of such "solutions," the greater the water and detergent content, at least within practical operating ranges, the greater the electrical conductivity. Within any given system utilizing a particular water-immiscible dry cleaning organic solvent, a particular detergent and water, a substantially fixed relationship exists with respect to the variability of the electrical conductivity as a function of the quantity of detergent and water, particularly the latter, dissolved or colloiddally dispersed in the organic solvent in the form of the aforesaid "solutions." Thus, with any given system, for example, one

utilizing Stoddard solvent as the dry cleaning organic solvent, di-(2-ethylhexyl) sodiumsulfosuccinate as the dispersing agent or detergent, and distilled water as the source of water, it is possible to plot curves showing the relationship of electrical conductivity to detergent and water content, particularly the latter, within practical limits of the latter. Other curves can readily be prepared based upon electrical conductivity data utilizing any specific system of materials.

It will be understood that through continued use of the dry cleaning "solution" on different batches of soiled fabrics, said "solution" builds up a constantly varying amount of soluble impurities which affect to a greater or lesser extent, depending upon the amount and nature of such impurities, the electrical conductivity of said "solution." In the usual case, this is not sufficient substantially to affect adversely the conductivity readings so far as their reflecting the condition of the "solution" with respect to the content of water and detergent therein. In the usual case, the electrical conductivity readings of a "solution" containing a relatively high proportion of soluble impurities resulting from long continued use of the "solution" prior to distillation thereof will show a somewhat lower conductivity than a similar pure organic solvent solution containing only the same amounts of oil-soluble detergent and water. Suitable extrapolations can be resorted to, if desired, in situations of this kind, if deemed advisable, to take into account the effect of soluble impurities on the electrical conductivity of repeatedly used dry cleaning "solutions." Extreme temperature variations in the "solution" also influence the electrical conductivity value of the solution, high temperature increasing and low temperatures decreasing the electrical conductivity. Suitable allowances may be made for such temperatures variations and optimum results are enjoyed by maintaining the temperature of the "solution" between substantially 70° to 85° F.

While satisfactory results are obtained with electrical conductivities maintained at not less than about  $10 \times 10^{-7}$  mhos, I prefer to operate at higher levels as, for example, from about 40 to about  $120 \times 10^{-7}$  mhos or even higher, a particularly preferred range being from about 50 to about  $100 \times 10^{-7}$  mhos.

In the preferred manner of carrying out the present invention, in the so-called "two bath" system, for example, in dry cleaning systems which include a washer-filter-trap assembly reserved for the detergent "solution," and a separate rinse and filter system, and wherein said "solution" is continuously circulated through said washer-filter-trap assembly, the water-immiscible liquid organic solvent is activated with the requisite amount of oil-soluble non-volatile dry cleaning dispersing agent or detergent and the resulting solution is circulated through said assembly to effect uniform distribution of said dispersing agent or detergent throughout the entire body of organic solvent in the assembly. The requisite amount of water is then added and the resulting mixture is circulated through said assembly whereby to "solubilize" the water throughout the system, so that the "solubilized" water "solution" passes through the filter, and forms a substantially clear homogeneous solution having an electrical conductivity not less than about  $10 \times 10^{-7}$  mhos. The solid fabrics to be dry cleaned are then subjected to the resulting dry cleaning "solution" in the usual way, successive batches of soiled fabrics being dry cleaned. The electrical conductivity of the "solution" is measured and, if the electrical conductivity has dropped to below the aforesaid value, an additional amount of water and, if necessary, detergent is added to bring the concentration of the water and detergent and the electrical conductivity of the "solution" to within the predetermined ranges. It will, of course, be understood that after the fabrics are cleaned they are rinsed and dried and fluffed in accordance with standard practices in the art.

It will be understood that the addition of oil-soluble

5

dispersing agent or detergent to the organic solvent "solutions" will occur far more infrequently than the additions of water. In this connection, it will be appreciated that the solubility and stability of the oil-soluble dispersing agent or detergent are such that the content hereof diminishes quite slowly so that replenishing thereof is necessary at only relatively sporadic intervals. Hence, when the electrical conductivity drops below about  $10 \times 10^{-7}$  mhos it will, in most cases, be necessary to add only water in order to increase the electrical conductivity to a value above said minimum figure. The content of oil-soluble detergent in the dry cleaning "solution" can be determined from time to time by heretofore known procedures. It may be found, in certain instances, that when the electrical conductivity drops below the aforesaid minimum value there may be a deficiency of both detergent and water, and, in such cases, both detergent and water will be added to bring the amounts thereof within the desired or predetermined ranges as well as restoring the electrical conductivity of the dry cleaning "solution" to a value not below said minimum figure. In the usual case, however, as stated, water additions alone will be sufficient and the detergent content can be determined and maintained at desired proportions by procedures already known in the art.

An object of this invention is to provide an improved method for measuring or determining the electrical conductivity of the "solution" circulating through the dry cleaning system for the purpose of maintaining high cleaning efficiency in a simple and effective manner. In this respect all of the circulating "solution" in the dry cleaning system is circulated in a continuous manner through the conductivity measuring apparatus in order to obtain accurate and continuous measurements and determinations of the electrical conductivity thereof, and said conductivity measuring apparatus offers substantially no impedance or restriction to the circulation of the "solution."

A further object of this invention is to provide an improved method for automatically supplying water to the "solution" in the dry cleaning system for automatically maintaining the electrical conductivity of the "solution" at the desired values and to prevent an inadvertent and excessive supply of water thereto. The water is introduced into the system for the purpose of maintaining a certain minimum electrical conductivity value necessary for efficient cleaning, compatible with avoidance of damage to the fabrics, such as excessive wrinkling and shrinkage, which may be brought about by excess water. In this respect suitable water pipes, water reservoir and solenoid valves and signal lights controlled by the electrical conductivity measuring apparatus are utilized.

Other objects and advantages of this invention will become apparent to those skilled in the art upon reference to the accompanying specification, claims and drawings in which:

FIGURE 1 is an elevational view of a dry cleaning system useful in carrying out the method of this invention;

FIGURE 2 is a wiring diagram for the equipment illustrated in FIGURE 1;

FIGURE 3 is a vertical sectional view through the electrical conductivity responsive device and taken substantially along the line 3—3 of FIGURES 2 and 4;

FIGURE 4 is a horizontal sectional view taken substantially along the line 4—4 of FIGURE 3;

FIGURE 5 is a horizontal sectional view taken substantially along the line 5—5 of FIGURE 3;

FIGURE 6 is a sectional view of one of the spacer members illustrated in FIGURE 3;

FIGURE 7 is an enlarged partial sectional view showing the manner of making electrical contact with the electrodes as illustrated in FIGURE 3;

FIGURE 8 is a vertical sectional view similar to FIGURE 3 but illustrating a further form of the invention and taken substantially along the line 8—8 of FIGURE 9;

6

FIGURE 9 is a horizontal sectional view taken substantially along the line 9—9 of FIGURE 8;

FIGURE 10 is a horizontal sectional view taken substantially along the line 10—10 of FIGURE 8;

FIGURE 11 is a sectional view through one of the spacer members illustrated in FIGURE 8.

Referring first to FIGURE 1 there is generally illustrated a conventional dry cleaning system or apparatus such as known in the trade as "Prosperity 6A." It includes a dry cleaning washer 10 supported by feet 11 and having an access door 12 through which apparel to be dry cleaned is inserted. It also includes a filter 13 supported by feet 14 and having a removable cover 15. The filter 13 is provided with an inlet fitting 16 and an outlet fitting 17.

The dry cleaning "solution" is withdrawn from the washer 10 through a conduit 20, a button trap 21 and a conduit 22 by means of a pump 23 driven by an electrical motor, not shown. The pump discharges through a conduit 24 into the filter 13 through the fitting 16. The conduit 24 may be provided with a sight glass 25. The "solution" is discharged from the filter 13 through the discharge fitting 17, an upwardly extending conduit 26, a horizontally extending conduit 27 and a downwardly extending conduit 28 into the washer 10. Thus, the pump 23 operates to circulate the "solution" from the washer 10 through the button trap 21, the filter 13 and back to the washer 10. A valve 29 and a sight glass 30 may be located in the horizontal conduit 27. The conductivity device 31 of this invention is preferably vertically arranged in the vertical conduit 26 adjacent the horizontal conduit 27 on the discharge side of the filter 13. In this connection the conductivity responsive device 31 is connected by a reducing fitting 32 to the conduit 26 and by a T-fitting 33 to the conduit 27. One through leg of the T-fitting 33 is secured to the conductivity responsive device 31 and the other through leg thereof is closed by a plug 34. The normal leg is connected to the horizontal conduit 27.

The details of construction of the electrical conductivity responsive device are illustrated in FIGURES 3 to 7. It is shown to be constructed for use with a two inch conduit system, that is, where the vertical conduit 26 is formed from standard two inch pipe. Here, the electrical conductivity responsive device 31 includes a cylindrical housing 36 which may be formed from a three inch pipe or it may be formed from a casting, if so desired. The cylindrical housing 36 is threaded at its lower end as indicated at 37 and is secured to the reducing coupling 32 which in turn is secured to the conduit 26. The housing is also threaded at its upper end as indicated at 38 so that it may be secured to the T-fitting 33 which in this instance is a three inch T-fitting wherein the through legs of the T-fitting are three inch and the normal leg is of smaller size as, for example, a two inch leg for connection to the horizontal conduit 27 when it is a two inch conduit. Centrally located within the housing 36 are a pair of concentric tubular metallic electrodes 39 and 40. These electrodes 39 and 40 may be made of any suitable metal which will not be affected by the "solution." For example, the inner electrode 39 may be formed of No. 16 gauge seamless steel tubing having an outside diameter of  $2\frac{1}{8}$  inch and the outer electrode 40 may be formed of No. 16 gauge seamless steel tubing having an outside diameter of  $2\frac{1}{2}$  inch. It will be noted here that the inside diameter of the inner tubular electrode 39 is substantially the same as the inside diameter of the two inch conduit 26 so that the electrodes 39 and 40 will not restrict the flow of the "solution" through the dry cleaning system. The electrodes 39 and 40 are held in concentric relation within the housing 36 by means of lower and upper spacer members 41 and 42.

The lower and upper spacer members 41 and 42 are each provided with a central opening 44 which corresponds to the inside diameter of the inner electrode 39. The spacer members 41 and 42 are made of an electrical

7

insulating material such as Lucite. Adjacent the opening 44 in the spacer member there is provided an annular seat 45 which receives the end of the inner electrode 39. It is also provided with an annular seat 46 of larger diameter for receiving the end of the outer electrode 40. Between the seats 45 and 46 the spacer member is provided with a plurality of openings 47 so that the "solution" in addition to flowing through the inner tubular electrode 39 is also allowed to flow between the inner electrode 39 and the outer electrode 40. Substantially free flow of the "solution" is provided between the electrodes 39 and 40 because of the relatively large number of these openings 47. The inner electrode 39 is secured to the lower spacer member 41 by means of a screw 49 received in a counterbored hole 50 in the spacer member, the screw 49 being screwed into a tapped hole in the lower end of the inner electrode 39.

The lower spacer member 41 is secured in place in the housing 36 by means of a pair of screws 51 and 52 which are screwed into the spacer member 41. It is here noted that the screws 51 and 52 do not touch either electrode 39 and 40 so that there can be no electrical conduction between the electrodes 39 and 40 and the housing 36 through these screws 51 and 52. The screws 51 and 52 are sealed against leakage by washers or gaskets 53 which may be formed of Lucite. In this way the spacer member 41 is secured to the housing 36 which in turn concentrically mounts the lower ends of the tubular electrodes 39 and 40. The upper spacer member 42 is secured to the housing 36 by means of a pair of screws 54 and 58. The screw 54 is threaded into the upper end of the inner electrode 39 so as to make electrical contact therewith. The screw 54 is sealed against leakage and is electrically insulated from the housing 36 by means of an electrical insulator 55 which also may be made of Lucite. The screw 54 has a tapped hole therein for receiving a screw 56 to form an electrical connector for a conductor 57. The screw 58 is threaded into the upper end of the outer electrode 40 so as to make electrical contact therewith. It is also sealed against leakage and electrically insulated from the housing 36 by means of an insulator 55 and it is also provided with a tapped hole for receiving a screw 56 for forming an electrical connection to a conductor 59. Thus, the screws 54 and 58 in addition to securing the upper spacer member 42 and the upper ends of the electrodes 39 and 40 in place, also act as electrical connectors for making electrical connection to the electrodes 39 and 40, respectively.

It is therefore seen that all of the "solution" being circulated through the dry cleaning system is circulated through the electrical conductivity responsive device 31, the "solution" passing through the inner electrode 39 and between the inner and outer electrodes 39 and 40. Thus, the electrodes 39 and 40 may operate continuously to measure or determine the electrical conductivity of the "solution." At the same time the electrical conductivity responsive device 31 offers substantially no restriction or resistance to the flow of the "solution" therethrough. In this way accurate determinations may be made.

In FIGURES 8 to 11 the electrical conductivity responsive device 31 is constructed for use with a three inch conduit system, that is, where the vertical conduit 26 is formed from a pipe of three inch diameter. Here, the housing 36 is made larger as, for example, from a four inch pipe and likewise the T-fitting 33 is a four inch fitting. However, the electrodes 39 and 40 may be of the same size as in FIGURES 3 to 7 so that they may be interchangeably used. Here, the spacer members are designated at 62 and 63. They correspond in all respects to the spacer members 41 and 42 with the exception that they are provided with a plurality of outwardly extending ears 64 to form openings between the spacer members and the housing 36, these openings being designated at 65. The ears 64 may be integrally formed on the spacer members 62 and 63 or they may be made from

8

separate pieces such as Lucite which in turn are secured to the spacer members 62 and 63 by a suitable cement such as ethylene dichloride. The "solution" flowing through the electrical conductivity responsive device 31 in FIGURE 8 in addition to flowing through the inner electrode 39 and between the inner electrode 39 and the outer electrode 40 also flows between the outer electrode 40 and the housing 36. In this way substantially no restriction or resistance to the flow of the "solution" is provided by the electrical conductivity responsive device and yet, accurate measurements of the electrical conductivity of the "solution" may be obtained.

Referring now to FIGURES 1 and 2, the system utilized in the practice of this invention includes an electrical resistance responsive device 70 for measuring or determining the electrical conductivity of the "solution" flowing through the dry cleaning system. This electrical resistance responsive device may comprise an adjustable Wheatstone bridge arrangement. It has a terminal strip 71 and a selector switch 72 cooperating with indicia 73 for determining the adjustment of the bridge. The bridge may be powered by any suitable source of electrical energy transmitted thereto through line wires 74 and 75 connected to terminals 76 and 77, respectively. One of the legs of the bridge circuit may be connected to terminals 78 and 79 which in turn are connected by the conductors 57 and 59 to the electrodes 39 and 40 in the electrical conductivity responsive device 31. In this way the electrical conductivity of the "solution," as determined by the resistance to current flow therethrough, is utilized for balancing and unbalancing the bridge in the electrical resistance responsive device 70, the balancing point of which may be adjusted to any desired value by manipulating the knob 72. The bridge circuit in the electrical resistance responsive device 70 operates switching means for connecting the line wires 74 and 75 across the terminals 80 and 81 and for connecting those line wires across the terminals 80 and 82. When the electrical conductivity of the "solution" is above a predetermined value as determined by the setting of the control knob 72, the line wires 74 and 75 are connected across the terminals 80 and 81 by the switching mechanism. When the electrical conductivity of the "solution" is below the predetermined value, the line wires 74 and 75 are connected across the terminals 80 and 82.

Water is supplied to the "solution" from a water reservoir 85 which is suitably supported in an elevated position as by securing the same to the conduit 28 as indicated in FIGURE 1. Water is supplied to the reservoir 85 by means of a water supply pipe 86. A solenoid valve consisting of a valve 87 and a solenoid operator 88 is located in the pipe 86 for turning on and off the water. The pipe 86 also has a second valve 89 which is controlled by a float 90 responsive to the level of the water in the reservoir 85. When the solenoid 88 is energized to open the valve 87, water flows into the reservoir 85 up to a predetermined level therein whereupon the float 90 closes the valve 89 to shut off the supply of water to the reservoir. Water is fed from the reservoir 85 into the conduit 22 and, hence, into the circulating "solution" in the dry cleaning system through a pipe 91 which is connected by a petcock 92 into the conduit 22. By suitably adjusting the petcock 92 the rate of water feed into the water "solution" may be regulated. The pipe 91 is preferably provided with a strainer 93 for keeping foreign matter out of the "solution." The flow of water through the pipe 91 may be turned on and off by a valve 94 operated by a solenoid 95. When the solenoid 95 is energized, the valve 94 is opened to supply water to the "solution" and when the solenoid 95 is deenergized, the valve 94 is closed. A signal light 96 having an indicating lamp 97 is connected in parallel with the solenoid 95 so that the signal light is illuminated while water is being supplied to the "solution" in the dry cleaning system. To prevent opening of the valve 94 when the

pump 23 is not running there is provided a relay having an operating coil 98 for operating a switch arm 99, the operating coil 98 being connected by conductors 100 and 101 to the controlling switch for operating the motor which drives the pump 23.

In starting the dry cleaning system the water reservoir 85 is first filled with water and then the pump 23 is turned on for circulating the "solution" through the washer and filter. The "solution" is checked for the amount of oil-soluble non-volatile dry cleaning detergent to assure that a proper amount of the detergent is present in the "solution." The automatic control system is then activated. When the pump 23 is placed in operation, the switch 99 operated by the operating coil 98 is closed. If the electrical conductivity of the "solution" is below the desired value as determined by the control knob 72, a circuit is completed from the line wire 74 through terminal 76, terminal 82, conductor 105, switch 99, signal light 97 and solenoid 95 connected in parallel, conductor 103, terminal 80 and terminal 77 back to the line wire 75. This energizes the solenoid 95 for opening the valve 94 to supply water from the reservoir 85 to the conduit 22 and, hence, to the "solution" in the dry cleaning system. The rate of application of the water to the "solution" is regulated by the petcock 92. At the same time the signal light 97 is illuminated. When the electrical conductivity of the "solution" reaches the desired value, the aforementioned circuit is broken and another circuit is completed from the line wire 74 through terminal 76, terminal 81, conductor 104, solenoid 89, conductor 103, terminal 80 and terminal 77 back to the line wire 75, this circuit being completed at the same time that the aforementioned circuit is broken. As a result, the signal light 96 is extinguished, the solenoid 95 is deenergized to close the valve 94 to shut off the supply of water to the "solution" and the solenoid 88 is energized to open the valve 87 to supply water to the reservoir 85 until the level of the water in the reservoir reaches a predetermined value as controlled by the valve 89 in turn controlled by the float 90. Thus, during the period that water is not being supplied to the "solution" water is being supplied to the reservoir 85 for filling the same. If for some reason the control apparatus should not operate properly so as to tend to supply water to the "solution" in excessive amounts, the amount of water so supplied is limited by the size of the reservoir 85. In this way it is impossible to add excessively large amounts of water to the "solution." Also in this way the correct amount of water is maintained in the "solution" for providing maximum dry cleaning efficiency.

When garments are placed in the washer 10, they will absorb some of the water in the "solution" and when this occurs, the control system of this invention automatically operates to replenish the water so absorbed so as to maintain at all times maximum cleaning efficiency regardless of the character of the garments being cleaned and the moisture content carried by such garments. The signal light 96 is illuminated during the time that water is being supplied to the "solution" and it is found that under normal operating conditions water will be supplied to the "solution" during the cleaning cycle for about two to five minutes, the cleaning cycle usually running from ten to twenty minutes depending upon the type of garments being cleaned. If water is introduced intermittently during a cleaning cycle for shorter periods, this means that the water is being introduced at too great a rate and to remedy this the petcock 92 is closed off somewhat in order to obtain the correct cycling. If water is admitted to the "solution" for longer periods than this two to five minute period, this indicates that something is wrong and the operator is advised of this by the signal light 96. The amount of water introduced into the "solution" may be regulated by adjusting the control knob 72 on the electrical resistance responsive device 70, the knob being turned in one direction for increasing the amount of

water in "solution" and in the other direction for decreasing the amount of such water.

While for purposes of illustration one main form of equipment through the utilization of which the method of this invention may be practiced has been disclosed, other forms of equipment may become apparent to those skilled in the art upon reference to this disclosure, and therefore, this invention is to be limited only by the scope of the appended claims.

I claim as my invention:

1. In the dry cleaning of fabrics by the "two-bath" method in a system which includes a washer adapted to hold fabrics to be dry cleaned, a filter, conduits interconnecting the washer and filter and a pump for circulating through the washer, filter and conduits a water-immiscible organic dry cleaning solvent which is activated by small proportions of an oil-soluble non-volatile dry cleaning detergent and water so finely dispersed as to form a substantially clear homogeneous "solution," the steps which include placing the fabrics to be dry cleaned in the washer, circulating the said "solution" therethrough and continuously through said filter whereby to remove soil from said fabrics and whereby, upon initial contact of said fabrics with said "solution" a portion of the water in said "solution" is absorbed by said fabrics, and, promptly upon said absorption occurring, automatically admitting water into contact with said "solution" to effect at least a substantial replenishment of said initially absorbed water, said automatic admission of water being effected in response to a change in the electrical conductivity of said "solution" caused by said absorption of water from said fabrics by reason of the initial contact thereof by said "solution," the electrical conductivity of said "solution" during the washing cycle being maintained within the range of from about  $10$  to  $120 \times 10^{-7}$  mhos.

2. In the dry cleaning of fabrics by the "two-bath" method in a system which includes a washer adapted to hold fabrics to be dry cleaned, a filter, conduits interconnecting the washer and filter and a pump for circulating through the washer, filter and conduits a water-immiscible organic dry cleaning solvent which is activated by small proportions of an oil-soluble non-volatile dry cleaning detergent and water so finely dispersed as to form a substantially clear homogeneous "solution," the steps which include continuously determining the electrical conductivity of the "solution," placing the fabrics to be dry cleaned in the washer, circulating said "solution" therethrough and continuously through said filter whereby to remove soil from said fabrics and whereby, upon initial contact of said fabrics with said "solution," a portion of the water in said "solution" is absorbed by said fabrics which decreases the electrical conductivity of said "solution," and, promptly upon said absorption occurring with resultant decrease in electrical conductivity of said "solution," admitting water into contact with said "solution" in accordance with the decrease in electrical conductivity of the "solution" to effect at least a substantial replenishment of said initially absorbed water, the electrical conductivity of said "solution" during the washing cycle being maintained within the range of from about  $10$  to  $120 \times 10^{-7}$  mhos.

3. In the dry cleaning of fabrics by the "two-bath" method in a system which includes a washer adapted to hold fabrics to be dry cleaned, a filter; conduits interconnecting the washer and filter and a pump for circulating through the washer, filter and conduits a water-immiscible organic dry cleaning solvent which is activated by small proportions of an oil-soluble non-volatile dry cleaning detergent and water so finely dispersed as to form a substantially clear homogeneous "solution," the steps which include continuously determining the electrical conductivity of the "solution," initially admitting, if necessary, water in contact with said "solution" to bring the electrical conductivity and hence the water content thereof to desired values, placing a batch of the fabrics to be

dry cleaned in the washer, circulating said "solution" therethrough and continuously through said filter for a desired interval of time whereby to remove soil from said fabrics and whereby, at the beginning of said time interval a portion of the water in said "solution" is absorbed by said fabrics which decreases the electrical conductivity of said "solution," and, during said time interval and promptly upon said absorption occurring with resultant decreases in electrical conductivity of said "solution," admitting water into contact with said "solution" in accordance with the decrease in electrical conductivity of the "solution" to effect at least a substantial replenishment of said initially absorbed water, the electrical conductivity of said "solution" during the washing cycle being maintained within the range of from about 10 to  $120 \times 10^{-7}$  mhos.

4. In the dry cleaning of fabrics by the "two-bath" method in a system which includes a washer adapted to hold fabrics to be dry cleaned, a filter, conduits interconnecting the washer and filter and a pump for circulating through the washer, filter and conduits a water-immiscible organic dry cleaning solvent which is activated by small proportions of an oil-soluble non-volatile dry cleaning detergent and water so finely dispersed as to form a substantially clear homogeneous "solution," the steps which include continuously determining the electrical conductivity of the "solution," initially admitting, if necessary, water in contact with said "solution" to bring the electrical conductivity to desired values, placing a batch of the fabrics to be dry cleaned in the washer, circulating said "solution" therethrough and continuously through said filter for a time interval of about ten minutes to twenty minutes whereby to remove soil from said fabrics and whereby, at the beginning of said time interval a portion of the water in said "solution" is absorbed by said fabrics which decreases the electrical conductivity of said "solution," and, for about two minutes to five minutes during said time interval and promptly upon said absorption occurring with resultant decrease in electrical conductivity of said "solution," admitting water into contact with said "solution" in accordance with the decrease in electrical conductivity of the "solution" to effect at least a substantial replenishment of said initially absorbed water, the electrical conductivity of said "solution" during the washing cycle being maintained within the range of from about 10 to  $120 \times 10^{-7}$  mhos.

5. In the dry cleaning of fabrics by the "two-bath" method in a system which includes a washer adapted to hold fabrics to be dry cleaned, a filter, conduits interconnecting the washer and filter and a pump for circulating through the washer, filter and conduits a dry cleaning "solution" in the form of a water-immiscible organic dry cleaning solvent which is activated by small proportions of an oil-soluble non-volatile dry cleaning detergent and water so finely dispersed as to form a substantially clear homogeneous "solution," the steps which include initially adding said detergent and water to said dry cleaning solvent and circulating said mixture through said washer and filter until said "solution" is formed, then placing the fabrics to be dry cleaned in the washer, continuously circulating the said "solution," during a washing cycle, through said washer and filter whereby to remove soil from said fabrics and deposit the organic solvent-insoluble soil in said filter and whereby, upon initial contact of said fabrics with said "solution" a portion of the water in said "solution" is absorbed by said fabrics, and, promptly upon said absorption occurring, automatically admitting water into contact with said "solution" on the inlet side of said pump to effect at least a substantial replenishment of said initially absorbed water and to pass it through said filter before admission to said washer, said automatic admission of water being effected by means of an electrical resistance device responsive to a change in the electrical conductivity of said "solution" caused

by said absorption of water from said fabrics by reason of the initial contact thereof by said "solution," the electrical conductivity of said "solution" during the washing cycle being maintained within the range of from about 10 to  $120 \times 10^{-7}$  mhos.

6. In the dry cleaning of fabrics by the "two-bath" method in a system which includes a washer adapted to hold fabrics to be dry cleaned, a filter, conduits interconnecting the washer and filter and a pump for circulating through the washer, filter and conduits a dry cleaning "solution" in the form of a water-immiscible organic dry cleaning solvent which is activated by small proportions of an oil-soluble non-volatile dry cleaning detergent and water so finely dispersed as to form a substantially clear homogeneous "solution," the steps which include initially adding said detergent and water to said dry cleaning solvent and circulating said mixture through said washer and filter until said "solution" is formed, then placing the fabrics to be dry cleaned in the washer, continuously circulating the said "solution" during a washing cycle through said washer and filter whereby to remove soil from said fabrics and deposit the organic solvent-insoluble soil in said filter and whereby, upon initial contact of said fabrics with said "solution" a portion of the water in said "solution" is absorbed by said fabrics, and, promptly upon said absorption occurring, automatically admitting water into contact with said "solution" on the inlet side of said pump to effect at least a substantial replenishment of said initially absorbed water and to pass it through said filter before admission to said washer, said automatic admission of water being effected in response to a change in the electrical conductivity of said "solution" caused by said absorption of water from said fabrics by reason of the initial contact thereof by said "solution," all of said "solution" in the system, during any given washing cycle, being circulated past and in contact with the response effective means, the electrical conductivity of said "solution" during the washing cycle being maintained within the range of from about 10 to  $120 \times 10^{-7}$  mhos.

7. In the dry cleaning of fabrics by the "two-bath" method in a system which includes a washer adapted to hold fabrics to be dry cleaned, a filter, conduits interconnecting the washer and filter and a pump for circulating through the washer, filter and conduits a water-immiscible organic dry cleaning solvent which is activated by small proportions of an oil-soluble non-volatile dry cleaning detergent and from about 0.2% to about 0.4%, by volume, of water so finely dispersed as to form a substantially clear homogeneous "solution," the steps which include continuously determining the electrical conductivity of the "solution," initially admitting, if necessary, water in contact with said "solution" to bring the electrical conductivity to within the range of from about 10 to  $120 \times 10^{-7}$  mhos, placing a batch of the fabrics to be dry cleaned in the washer, circulating said "solution" therethrough and continuously through said filter for a time interval of about ten minutes to twenty minutes whereby to remove soil from said fabrics and whereby, at the beginning of said time interval, a portion of the water in said "solution" is absorbed by said fabrics which decreases the electrical conductivity of said "solution," and, for about two minutes to five minutes during said time interval and promptly upon said absorption occurring with resultant decrease in electrical conductivity of said "solution," admitting water into contact with said "solution" in accordance with the decrease in electrical conductivity of the "solution" to effect replenishment of said initially absorbed water to an extent to bring it to within the range of about 0.2% to about 0.4%, by volume.

8. In the dry cleaning of fabrics by the "two-bath" method in a system which includes a washer adapted to hold fabrics to be dry cleaned, a filter, conduits interconnecting the washer and filter and a pump for circulat-

ing through the washer, filter and conduits a dry cleaning "solution" in the form of a water-immiscible organic dry cleaning solvent which is activated by small proportions of an oil-soluble non-volatile dry cleaning detergent and from about 0.2% to about 0.4%, by volume, of water so finely dispersed as to form a substantially clear homogeneous "solution," the steps which include initially adding said detergent and water to said dry cleaning solvent and circulating said mixture through said washer and filter until said "solution" is formed, continuously determining the electrical conductivity of the "solution," initially admitting, if necessary, water in contact with said "solution" to bring the electrical conductivity to within the range of from about  $40$  to  $100 \times 10^{-7}$  mhos, placing a batch of the fabrics to be dry cleaned in the washer, continuously circulating said "solution," during a washing cycle, through said washer and filter for a time interval of about ten minutes to twenty minutes whereby to remove soil from said fabrics and deposit the organic solvent-insoluble soil in said filter and whereby, at the beginning of said time interval, a portion of the water in said "solution" is absorbed by said fabrics which decreases the electrical conductivity of said "solution," and, for about two minutes to five minutes during said time interval and promptly upon said absorption occurring with resultant decrease in electrical conductivity of said "solution," automatically admitting water into contact with said "solution" in accordance with the decrease in electrical conductivity of the "solution" to effect replenishment of said initially absorbed water to an extent to bring it within the range of about 0.2% to about 0.4%, by volume, said automatically admitted water being introduced on the inlet side of said pump whereby it passes, in said "solution," through the filter before passage into the washer.

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