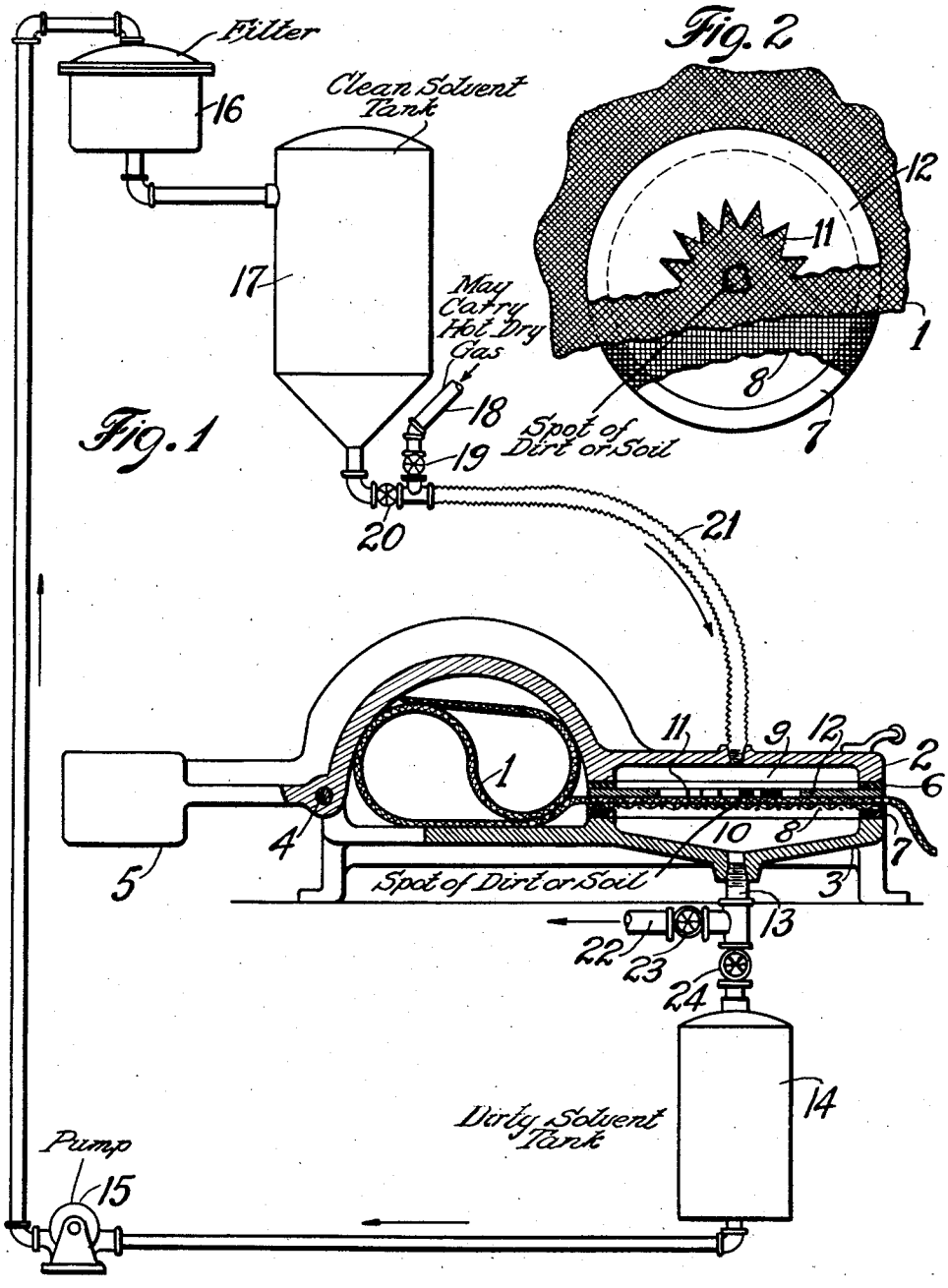
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PROCESS OF CLEANING

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INVENTOR

Justin F. Wait

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PROCESS OF CLEANING

Justin F. Wait, New York, N. Y., assignor to John C. Wait, New York, N. Y.

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This process relates to improvements in methods of cleaning fabrics and other porous material by means of liquid solvent. It is also applicable to methods of extraction of soluble substances from a porous material.

The common method of cleaning stains or cloths and other porous materials usually involves the agitation or mixing of said cloths or material with a solvent capable of removing the stain or other impurities contaminating the same. In other instances, the surface is rubbed or "sponged" with the solvent or cleaning agent. In either case the penetration of the solvent is limited by the extent of diffusion or seepage. Such treatment is not thorough and an appreciable part of the liquid containing the impurity is left in the pores and on the surface and evaporates leaving the impurity.

The sponging is not as efficient as is desired and frequently proves to be but a surface reaction wherein the stain is apt to again become visible. Agitation and/or mixing of a porous material with a fluid is invariably inconvenient, and requires the treatment of all parts of the surface alike and is more costly. This method is very hazardous when a flammable solvent is used especially in view of the large amount of solvent involved.

My invention involves positive motion of a solvent through the pores of the material such as woven cloth with pores or other similar or equivalently acting porous material which similarly takes common stains and/or collects particles of dirt which adhere thereto and which material is of organic matter and flexible, the motion, solvent action and direction of flow rapidly causing removal of the stain by reason of solution and velocity. By pores is meant the interstices or spaces between parts of the material such as tubular openings or fissures. In my process, the passing or flow of a cleaning fluid is made positive by pressure. The direction of flow is preferably into the surface opposite that which first became contaminated and/or that which is most heavily saturated with the stain. The expression or prefix "contra to" indicates that the direction of flow is thus. This prevents further impregnation of non-contaminated portions of the porous material, with the stain. It likewise prevents colloids or suspended substances from being rubbed or otherwise forced into the pores as is the case with the common methods. The amount of solvent involved is small.

To facilitate solution of stains or other contaminating substance, a multiplicity of solvents may be used to advantage and preferably in sequence. For example, a medium light petroleum distillate seems to remove a waxy stain more easily than a light petroleum distillate, but would itself stain the porous material wherefor a light distillate should follow a medium or heavy distillate. In this manner the final solvent wetting the fibre is easily volatilized, leaving the porous material substantially free from solvent after the process has been completed.

It is possible to clean some fabrics by using aqueous or alcoholic solvents containing salts of fatty acids such as soap and like agents. High economy may be had if such cleaning fluid is reused. The cleaning fluid may be purified between cycles or at intervals. The term solvent as used herein includes solvents containing an agent.

Cleaning of a material yields a nascent surface by thus exposing a new or fresh surface of the material and of colored portions of a stain contained thereon. I have found it advisable to add a bleaching agent to such cleaned surfaces. It thus acts without appreciable lapse of time.

Rays such as may be emitted from an ultraviolet ray tube influences the color and occasionally the ultimate solubility of substances. Such rays or other effects may be formed or generated at a convenient point. For example, gaseous fluid may be treated as disclosed in my applications Ser. Nos. 294,141, 433,704 and 449,338. My process includes application of such rays to aid in the removal of colored stains and also to improve color. The ray may act indirectly and be formed within the fluid which treats the porous material or the rays may be formed at the region of treatment and so act directly. With indirect action the actual performance is probably due to ionization of the fluid, other like methods of producing such ionization or equivalent action I consider as being the equal of treatment with ray.

In cleaning a limited area the part surrounding the cleaned spot may be appreciably soiled and therefore of a different color by comparison. To correct the resulting appearance, I have found it advantageous to treat the border of the first area to a lesser degree as by sponging or passage of a less effective flow of a solvent. Likewise the eye may be deceived by making the border of the area irregular as for example like a many pointed star which limits the action to a controlled area. The so-formed blending edge

causes the change in appearance to be gradual and therefore less noticeable. This blending effect makes it possible to remove heavy stains from partially soiled materials without emphasizing the degree of soil.

Gaseous fluids such as ozone-containing air which are ionized or will ionize to yield active portions and steam may be used to assist in cleaning. These are preferably controlled as to temperature, amount and velocity.

If it is desired to give a color to the porous material the process may be operated to allow a dyeing agent to contact therewith. In this case it is generally preferable to first clean the surface and to subsequently pass a dyeing agent through the area cleaned. This method of dyeing porous material has considerable advantage including thoroughness of applying the color and uniformity. The dyeing step may involve passage of two or more fluids through the porous material. The ordinary method of dyeing a limited area involves printing which does not give uniformity throughout the thickness.

The illustrations show means by which one modification of my invention may be carried out. Figure 1 is a side view of the apparatus, the fabric holding device being shown partly in section and on a larger scale than the rest of the apparatus. Figure 2 is a plan view of the diaphragm of the cloth holding device and parts immediately below it, parts being broken away.

A piece of porous material 1 which may be cloth or other piece of fabric to be cleaned is clamped or held between circular jaws 2 and 3 which are adapted to swing and operate about pivot 4, the counterweight 5 being used to facilitate operation and clamps not shown being used to hold the jaws tight together or in an open position. Gaskets 6 and 7 are used to make a tight connection between the jaws, the porous material and the porous support 8 which may be comprised of a screen of appropriate mesh, voids in the outer edges of which are filled in, to form a smooth contact with gasket 7. The supporting screen is selected so as to afford like flow through all portions of the cloth or other porous material in the line of flow. It is preferred that the mesh of the screen approximate the mesh of the cloth or be of the same general order and kind as illustrated. As an example a finely woven fabric would be supported by a finely woven screen. Perforations with dead areas between holes are not suitable for any but very coarse weaves. A sample of about the weave or porosity to be treated is preferably tried out to determine whether the flow is substantially uniform throughout the line of flow so that the cleaning will be uniform.

The chamber 9 is filled with a fluid under pressure with the respect to fluid contained in chamber 10. This causes such fluid to pass through a limited area contained within the blending edge 11 of the disc 12 shown in detail in Fig. 2. I call or designate the optical effect, so obtained by the disc 12 with its extended points or distended edge, "blending". The shape need not be regular or symmetrical but should be such as to gradually reduce the area, of outwardly successive annular increments, to zero. The piece of goods is so placed as to yield flow in contra direction as regards the direction of attachment or flow of the contaminating substance (s).

The fluid, in passing through the porous material 1, will remove stains and other forms of contamination therefrom which may be contained within the limited and controlled area within the edges 11. The use of this disc or its equivalent insures permanency of the optical effect which yields gradual change as between the cleaned area and other area which may be somewhat soiled. The liquid in being forced through the material permanently cleans to the imposed shape and this is in contrast with sponging which is but a temporary surface action and which permits capillary or other action to again draw out oily substance and collection of dust thereon. After the fluid has so removed such impurities either by solution or mechanical movement, it is forced into chamber 10, through outlet 13 and into a receiver 14 wherefrom it may be forced as by means of a pump 15 through a filter 16 into storage tank 17. The purification by filtration in 16 may be supplemented by or substituted for by settling or other separation means.

If the cleaning liquid which is passed from the porous material 1 and chamber 10 is to be wasted or used or stored externally to the process it may be discharged as from line 22 such operation being controlled as by means of valves 23 and 24. These valves may also be used to assist in the control of the pressure within chamber 10. The line 22 may also be used to pass a fluid into chamber 10 and then discharged as from an opening in jaw 3 not shown or through line 18.

Vapors and other gaseous fluids other than ordinary air or hot air or the like, such as those obtainable by connecting to the discharge line from a pressure operated ozone generator, may be passed into chamber 9 by means of the connection 18 and actuating of valves 19 and 20. The connections may be made in the well known manner so that a multiplicity of liquids and/or fluids may be used, thus for example, a number of elements 14, 15, 16, 17 and 18 may be provided with appropriate piping and control valves so that two or more solvents and/or one or more gaseous fluids may be used. Likewise agitated, heated or other tanks may be provided for purposes such as mixing or preparing the solvent or dyeing agent. The inlet 21 to chamber 9 is preferably made of flexible metallic tubing. Fluid contained within chamber 9 may be under static head due to elevation of tank 17 or to the static head plus a pressure head developed as by means of pump 15.

For some parts of the operation such as drying, liquid contained within the porous material contacting chamber 10 may be removed by imposing a subatmospheric pressure on chamber 10. This may be supplemented by the application of heat such as may be produced by heating elements not shown but located in the vicinity or as by heating gaseous fluid passed into chamber 9 from the inlet 21.

The shapes of the jaws 2 and 3 and the disc 12 with its blending edge 11 may be varied as desired for the removal of stained portions of various shapes. The arrangement of the supporting screen 8, gaskets 6 and 7 and other mechanical details may be varied to suit the conditions and the results desired. The process may be modified to permit of the use of any desired cleaning agent and to produce desirable results on porous materials of different kinds.

I do not limit my claims to the number of processes described. The apparatus as illustrated may be varied and substitutions made to carry out the described and equivalent processes.

I claim:

1. The process of cleaning a porous material which comprises applying a cleaning fluid at a

selected zone of contamination, and flowing the fluid in substantial uniformity through a limited area, defined and controlled by an edge of materially distended points designed to blend the resulting cleaned area with uncleaned areas while preventing passage of appreciable amounts of fluid through neighboring areas.

2. The method of removing a soiled spot from a fabric which comprises flowing a solvent through a limited zone of said fabric, said zone having a multiplicity of distending edges to gradually decrease the areas of successively removed-from-the-center annular sections, dissolving and removing said soiled spot and subsequently sponging the border of the zone.

3. In cleaning a fabric with pores, the process which comprises rigidly supporting the fabric on a free draining member which will afford drainage of applied solvents from substantially all portions of a selected area of the fabric, placing the surface of greatest contamination of a soiled spot of substantial size against the free draining member in a manner that the spot is circumscribed by a plate designed to confine flow of applied solvent to a selected area, applying an oil-like solvent which will remove soil from the spot under a pressure which will afford a velocity which combined with solvent action will after a period of flow remove substantially all of the soil and which has rapidly flown through the cloth and the free draining member into a region beyond and out of contact with the fabric and so substantially removing the soil of the spot from the fabric subsequently flowing another oil-like but more volatile solvent similarly through the fabric and removing all portions of the less volatile solvent and then removing all of the residual more volatile solvent by evaporation to yield a dry clean area where the soiled spot had previously existed.

4. In a process of cleaning by applying solvent to a soiled porous surface of cloth goods, the steps which comprise rigidly clamping the goods about a soiled portion, forcing a solvent through the goods at substantial rate and in a direction from the side of the surface which is least contaminated to the side of the surface which is most contaminated with the soil which latter side is held adjacent to a free draining member adapted to prevent substantial distortion of the goods and permit of relatively free flow of the solvent and beneath a plate with an opening controlling the area of flow, thus flowing the solvent uniformly through the portion beneath the opening of the controlling plate, so removing impurities forming the soil, flowing a second and more volatile solvent miscible with the first solvent through the so cleaned portion of the goods in the same direction as the flow of the first solvent and so removing the first solvent in substantially its entirety and causing the residual solvent in the goods to be of the more volatile and so recovering the solvent of the goods easily removable, and then removing the second solvent from the surface and so forming a surface which has been cleaned by solvent action of a less volatile solvent and rendering the goods substantially free from solvent.

5. The process of cleaning and dyeing a fabric of low permeability which comprises applying a cleaning fluid at a selected zone of contamination, flowing the fluid at appreciable velocity and in substantial uniformity through a limited area designed to blend the so cleaned portion as regards uncleaned portions while preventing passage of appreciable amounts of fluid through neighboring areas, and subsequently flowing a dyeing agent through the so cleaned area and so dyeing the area cleaned.

6. In cleaning and dyeing a fabric material of low porosity, the method comprising flowing a cleaning fluid uniformly and at substantial velocity through a selected and defined portion of the fabric material while preventing passage of appreciable amounts of fluid through neighboring areas and so cleaning a defined area, flowing a dyeing agent through the same defined portion with substantial uniformity and so thoroughly and uniformly dyeing the selected portion.

7. The process of cleaning a soiled spot from a porous fabric, comprising supporting the fabric on a free draining member, confining the spot on the fabric by a plate confining the flow of applied solvent to a selected area of the fabric, flowing an oil-like solvent under pressure through said area, subsequently flowing a more volatile solvent through said area and thereby removing the first mentioned solvent, and finally removing the more volatile solvent by evaporation.

8. The process as in claim 7, the evaporation being effected by flowing air containing ozone through the fabric.

9. The method of cleaning fabric such as ordinary cloth which comprises establishing a limited area of the cloth containing a soiled spot, said area comprising gradually decreased areas of successively removed-from-the-center annular sections, flowing a solvent of components of the soil through the established area at appreciable velocity and substantial uniformity through all parts thereof while avoiding passage of appreciable amounts of solvent through neighboring areas and so substantially removing the soil and blending cleaned and uncleaned portions of the fabric.

10. The process of cleaning cloth which comprises applying cleaning liquid at a selected zone of contamination, flowing the liquid in substantial uniformity through a limited area, comprising gradually decreased areas of successively removed-from-the-center annular sections, to blend the resulting cleaned area with the adjacent uncleaned area, and preventing passage of substantial amounts of fluid through the adjacent areas.

11. In removing soluble substance from a fabric and improving the appearance thereof, the method of forcing a solvent, capable of removing soil contained on the surface adjacent to a rigidly supporting and free-draining surface, through the pores of said fabric in a single direction opposing that with which the soluble substance entered the fabric and with a substantial velocity in each and every pore within a defined and controlled area of the fabric while rigidly supporting the fabric to avoid appreciable distortion thereof and to remove substance soluble in the solvent and so clean the area and improve its appearance and thereafter forcing gas containing ozone through the fabric and so further improving the appearance of the surface of the area of the fabric which has been so treated.

12. In removing a soluble soil from, and brightening the surface of, a surface of cloth, the process which comprises forcing a solvent of low volatility which is effective, as regards the removal of the soil, through the cloth in a direction opposing the direction of entry of the soil and

at substantial velocity through all the pores of a selected area and for a period sufficient to remove substantially all of the soil, further purifying portions of the cloth of the selected area which has been so treated by displacing solvent wetting the cloth at the end of flow with a more volatile solvent by flow of substantial amounts of the more volatile solvent similarly through the cloth and subsequently improving the appearance of the so treated portions of the cloth by flowing air containing ozone through the cloth in similar manner to oxidize and bleach the selected area and remove portion of solvent therefrom and wherein the steps coactively operate in the indicated order to remove soluble soil and to brighten the surface thoroughly and to render the improvement durable.

JUSTIN F. WAIT.