Aug. 16, 1949. M. T. HOFFMAN 2,479,358

METHOD AND APPARATUS FOR DRY CLEANING

Filed Aug. 8, 1944 3 Sheets-Sheet 1

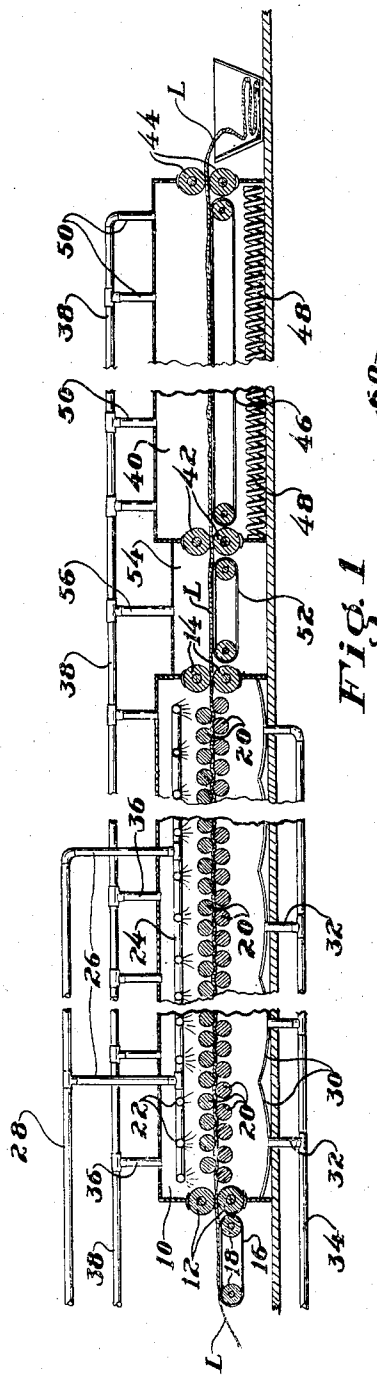


Fig. 1

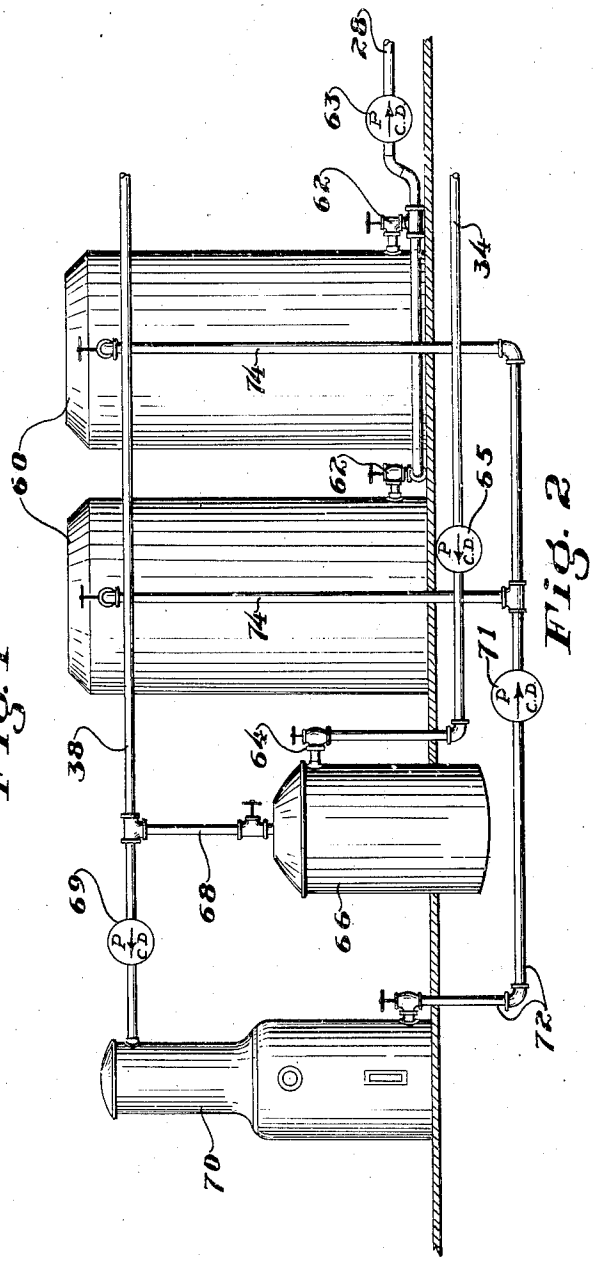


Fig. 2

Inventor
MANFRED T. HOFFMAN
By Edgar A. Kent
Attorneys

Aug. 16, 1949. M. T. HOFFMAN 2,479,358

METHOD AND APPARATUS FOR DRY CLEANING

Filed Aug. 8, 1944 3 Sheets-Sheet 2

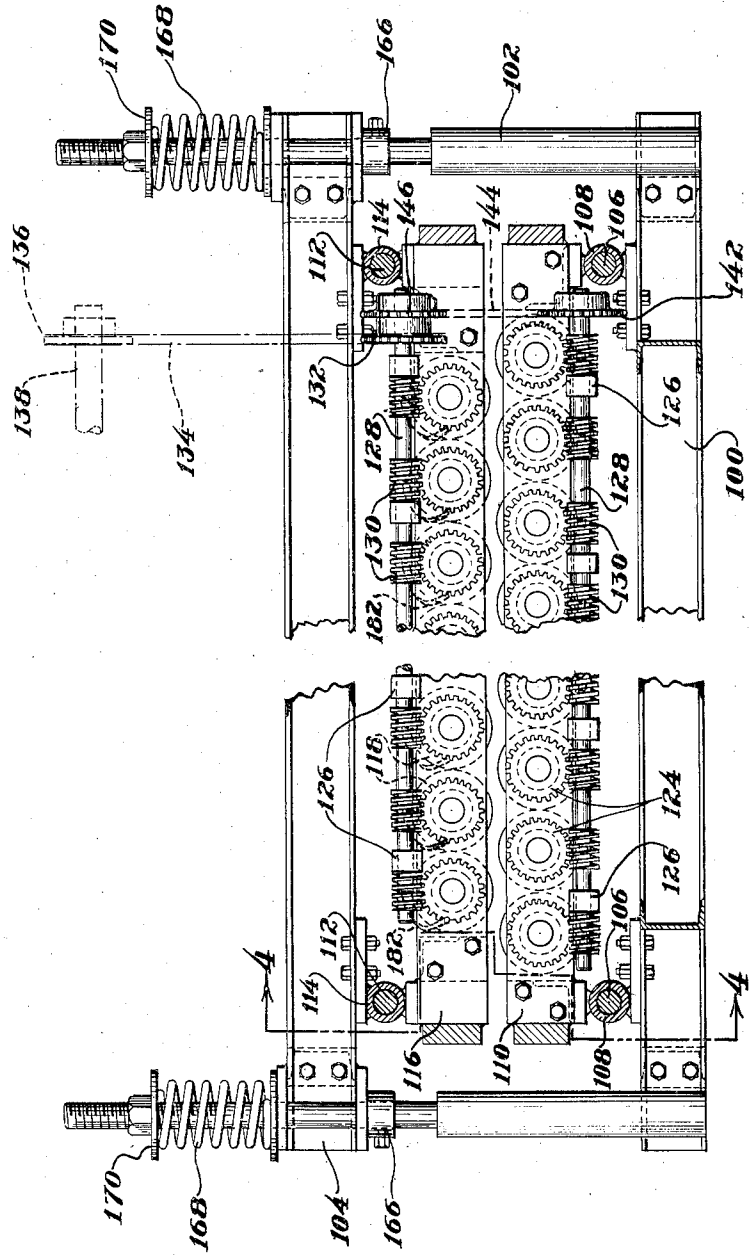


Fig. 3

Inventor
MANFRED T. HOFFMAN
By Edgar H. Kent
Attorneys

Aug. 16, 1949. M. T. HOFFMAN 2,479,358

METHOD AND APPARATUS FOR DRY CLEANING

Filed Aug. 8, 1944 3 Sheets-Sheet 3

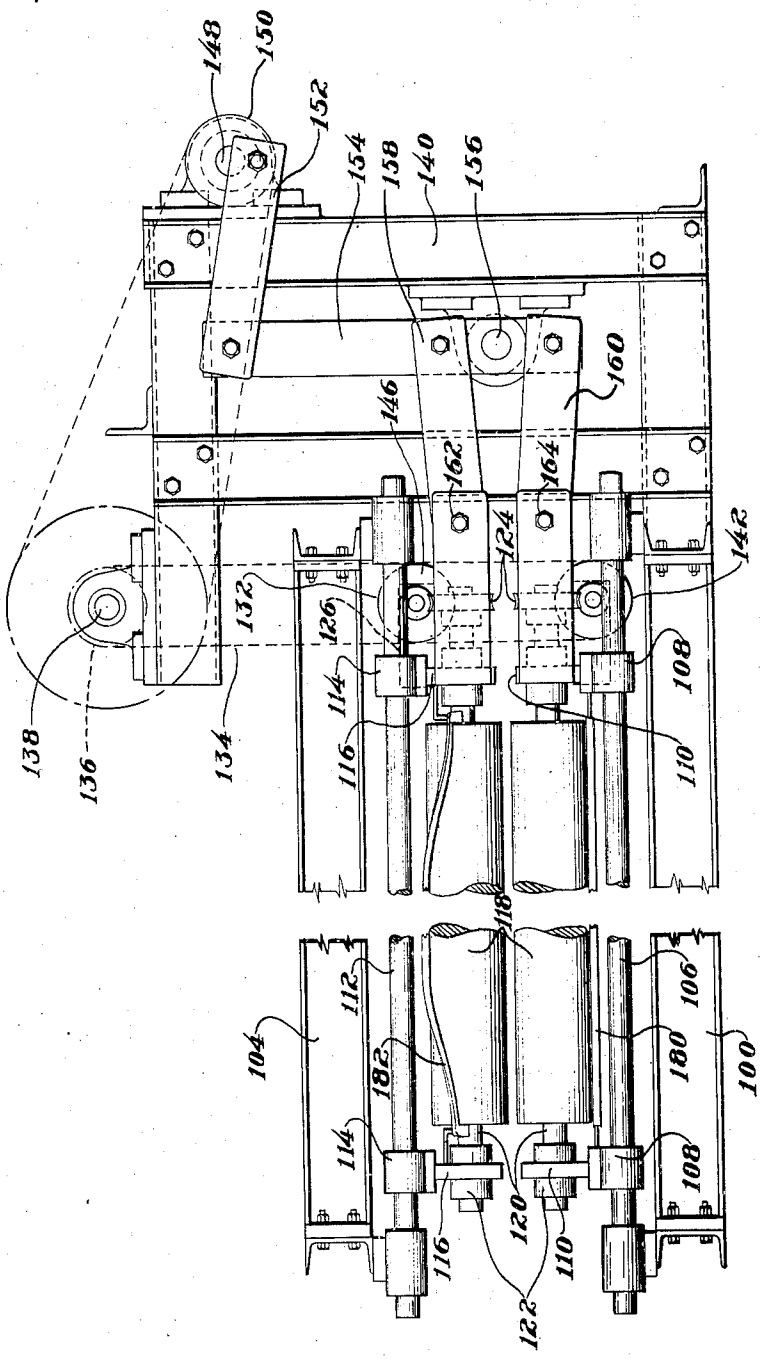


Fig. 4

Inventor
MANFRED T. HOFFMAN

By Edgar H. Kent
Attorneys

Patented Aug. 16, 1949 2,479,358

UNITED STATES PATENT OFFICE

2,479,358

METHOD AND APPARATUS FOR DRY CLEANING

Manfred T. Hoffman, Newburyport, Mass.

Application August 8, 1944, Serial No. 548,620

3 Claims. (Cl. 8—142)

1

This invention relates to methods and apparatus for dry cleaning wool and other animal fibres, hair, fur and skins, and other fibres and fibrous bodies with a dry cleaning solvent to remove grease, dirt, pitch, paint and other impurities.

Heretofore, solvent dry cleaning of such materials has been by batch methods in which a limited quantity of the material is immersed and sometimes agitated in a bath of the solvent, generally in a heated, sealed vessel, for a long period of time. After the batch of material has been washed with the solvent, it is usually subjected to further treatment, normally in the same vessel, for recovering solvent therefrom in a closed solvent recovery system.

An object of the invention is to provide a novel method and apparatus for solvent cleaning such materials in a continuous operation to which the material is automatically continuously fed and from which cleaned material is automatically continuously withdrawn, which is speedier, easier to operate and control, requires less hand labor and is less costly than prior methods. Another object is to provide such a method and apparatus with which an improved cleaning action of the solvent is obtained. Another object is to provide such a method and apparatus which are effective for simultaneously extracting the grease, pitch and paint from raw wool. Still another object is to provide such a method and apparatus with which the used solvent can be substantially fully recovered continuously and automatically and purified for re-use, with recovery of extracted grease as a by-product.

Any suitable dry cleaning chemical or solvent, or mixtures thereof, may be used. Examples of suitable solvent are chlorides of the hydrocarbons having more than one carbon atom such as trichlorethylene, perchlorethylene, dichlormethane, carbon tetrachloride, and tetrachlorethylene; also solvents such as dimethylketone, tretrahydronaphthalene, and cyclohexanol; also Stoddard solvent, gasoline and solvents of the naphtha family, although this latter group is less desirable because of relatively high inflammability.

In the method of the invention, the material is subjected to cleaning while in the form of an elongated layer which may be, according to the nature of the material being treated, a bat or felt or bodies of unwoven, unspun fibres or hairs, one or more thicknesses of a woven fibrous fabric or a succession of individual furs or skins. This layer of material is then advanced through a

2

cleaning zone in which fresh solvent is applied to one or both of its surfaces by spraying, dipping, flowing or brushing the layer, while wet with solvent, and while so disposed that the solvent is free to drain therefrom, is subjected to repeated intermittent squeezing action and preferably also to a working action which preferably includes both repeated alternate opposite flexings of the layer transversely of its length and repeated rubbing of its surfaces under pressure, preferably in opposite directions.

I have found that by such treatment the material can be cleaned of grease, pitch and like impurities in generally less time, and more adequately than with the conventional solvent bath process. Moreover, the process can be performed as a continuous operation with substantially complete automatic feed and control by means of novel apparatus of the invention hereinafter described.

Preferably the process is conducted with substantially complete recovery of used solvent and also of extracted impurities of the material which form valuable by-products such as lanolin and other greases. This is accomplished by conducting the cleaning operation in a closed chamber in which the used solvent and its fumes are confined for intermittent or continuous withdrawal in a suitable solvent purifying and recirculating system. In addition, the material after leaving the cleaning zone is preferably subjected to further treatment in a closed chamber for removal and recovery of substantially all absorbed solvent.

The preferred apparatus of the invention for conducting the process as a continuous cleaning operation includes, in the cleaning zone, a long succession of alternate upper and lower rollers between which the layer of material passes, and which are rotated to advance the layer therebetween. Each roller of the upper or lower set is arranged between the adjacent two rollers of the other set with their axes so spaced apart vertically that the layer of material passes over them in a sinuous path producing the alternate opposite transverse flexings of the layer, and with their axes so longitudinally spaced that the layer is squeezed as it passes between their opposed surfaces. The rollers, in addition to their rotary movement which advances the layer of material, are preferably also given an oscillatory movement, for example an opposite relative endwise oscillation of successive rollers, which further works the material layer by rubbing and scrubbing it. Means are provided for substan-

tially continuously supplying fresh solvent to the material as it is subjected to the action of these rollers, a system of solvent spray pipes arranged over the rollers being a preferred arrangement. The rollers and solvent applicators are enclosed in a substantially air-tight chamber which is connected in closed circuit with a solvent purification and recirculating system.

The apparatus will also generally include a subsequent chamber, also in closed circuit with the solvent purification and recirculation system, in which the cleaned layer of material is exposed to heat or steam or both to drive off absorbed solvent as recoverable vapor.

The process and apparatus will be further described in connection with the accompanying drawing, wherein:

Fig. 1 is a diagrammatic side elevation of cleaning and solvent recovery apparatus of the invention, with solvent purification and recirculating apparatus omitted;

Fig. 2 is a diagrammatic side elevation of solvent purifying and recirculating apparatus suitable for use with the apparatus of Fig. 1;

Fig. 3 is a detail view in side elevation, in part broken away, of working roller mechanism of the cleaning apparatus; and

Fig. 4 is a section view on line 4—4 of Fig. 3.

Referring now to Fig. 1 of the accompanying drawing, the cleaning apparatus therein indicated is housed by a substantially air tight chamber **10** having at opposite ends thereof a pair of entrance squeeze rollers **12** and a pair of exit squeeze rollers **14**. Preferably, these squeeze rolls are resiliently pressed together by springs or the like and the end walls of the chamber **10** are sealed closely about them so that they form part of substantially air tight end closures for the chamber. The material to be cleaned, in the form of a layer L, is fed to the bight between the entrance squeeze rollers **12**, which are rotated to advance the layer into the chamber **10**, by a suitable feed device, shown as an endless belt **16** running over pulleys **18**.

After leaving the entrance squeeze rolls **12**, the layer L is engaged by upper and lower banks of worker rolls **20** which extend between the entrance and exit squeeze rolls and are rotated to advance the layer L through the chamber **10** between said rolls. Rollers **20** are preferably arranged as shown with the rollers of each bank located between the axes of a pair of rollers of the other bank, and so spaced apart that each roller exerts a squeezing action on the layer as it passes between said roller and each of the adjacent pair of rollers of the other bank and so that the layer follows a somewhat sinuous path between the rollers. Some or all of the rollers **20** are oscillated in a manner to cause the two banks of rollers to rub or press the two surfaces of the layer in opposite directions, alternately one way and then the other, which greatly facilitates the penetration of solvent into the layer and its cleaning extractive action, particularly on the pigment of paint and tar. This oscillatory working action is preferably an endwise reciprocation of one of the banks of rollers, or of both banks in opposite directions, the effect of which is to rub or press the surfaces of the layer oppositely back and forth transversely of the layer.

As the layer L is advanced and worked by the rollers **20** it is continually wet with dry cleaning solvent from spray pipes **22** suspended above the upper bank of rollers **20** within chamber **10** and connected by branch pipes **24**, **26** with a solvent supply pipe **28**. The downwardly directed spray

from pipes **22** wets the layer directly where it is exposed between successive rollers **20** of the upper bank and also indirectly by wetting the surfaces of the upper rollers which in turn apply it to the layer. The used solvent, containing impurities extracted from the layer of material, drips to the bottom of the chamber **10** where it is collected in basins **30** from which it flows through branch pipes **32** into a drain pipe **34**. Fumes of the solvent, which may be applied in a heated condition, rise through branch pipes **36** in the top of the chamber into a collecting pipe **38**.

The number of worker rollers **20** which it is desirable to employ depends, of course, largely on the speed at which it is desired to process material with the machine, i. e., the speed of advance of the layer by the rollers. If a small number of rollers is used, the processing speed will have to be low in order to obtain sufficient application of solvent and working of the layer for efficient cleaning. I prefer to employ a large number of rollers, housed in a single elongated chamber, as shown, or alternatively in separate successive chambers, because adequate cleaning action can thus be obtained at a high rate of processing speed. Also, I prefer to employ enough spray pipes or other solvent applicators so that the layer is thoroughly wetted with the solvent while it is acted upon by the working rollers.

The apparatus shown in Fig. 1 includes a device for treating the cleaned layer to extract absorbed solvent remaining therein after it issues from the chamber **10**. This device comprises a housing forming a successive, substantially air-tight chamber **40** having at opposite ends thereof entrance and exit squeeze rolls **42** and **44** which are rotated to advance the layer into and out of the chamber, these rolls being constructed and arranged in the same manner as the rolls **12** and **14** to form a part of substantially air tight end closures for the chamber. Within the chamber **40**, between the rolls **42** and **44**, there extends an endless apron **46**, preferably of chain or open mesh construction which carries the layer from the rolls **42** to the rolls **44**. Below the apron **46** are located heating devices **48** which, by heating the advancing layer, vaporize off the absorbed solvent into the chamber from which it rises through branch pipes **50** into collecting pipe **38**. Apron **46** may be agitated to increase exposure of the interior of the layer to the heat. The layer of material is carried between the chambers **10** and **40** by an endless apron **52** which is itself housed in a chamber **54** in which any solvent fumes escaping from the layer are collected and passed to the collector pipe **38** through branch pipe **56**.

Steam may be used instead of dry heat to expel the solvent from the material in chamber **40** in which case said chamber will ordinarily be followed by a drying chamber.

The layer L may be, according to the nature of the material to be treated, one or more thicknesses of fabric, or a succession of skins or furs or wool hat bodies after being hardened or partly fulled, or a coherent bat of unwoven, unspun fibres. Where raw wool is to be cleaned, the apparatus shown in Fig. 1 will normally be preceded by bale openers, pickers to open up the wool and preferably also by a so-called squirrel cage or similar device for shaking out unadhered dirt such as disclosed in my U. S. Patent No. 2,292,076, issued August 4, 1942. Loose fibres are, of course, treated by any suitable means to form the bat or layer L which is delivered to the cleaning apparatus. After the cleaning operation, wool or other

fibrous materials may be subjected to crushing and dusting operations, with or without a preceding carbonizing step, to break down and shake out residues of pigment of paint and tar, shives and insoluble dirt particles remaining in the material.

In Fig. 2 of the drawing there is indicated suitable solvent purification and recirculating apparatus for the cleaning and solvent recovery apparatus of Fig. 1. In Fig. 2 solvent supply tanks for clean solvent are shown at **60** equipped with valved outlets **62** at the base through which solvent flows into supply pipe **28** of the cleaning apparatus through which it is pumped by pump **63**. The drain pipe **34** for the used solvent liquid of the cleaning apparatus is connected to a valved inlet **64** of a distiller **66** in which the liquid is distilled to separate the solvent as a volatile vapor from the dissolved grease, paint and other impurities, and to which the used solvent is pumped by a pump **65**. A filter (not shown) may be included in the pipe line **34**. The solvent vapors from the distiller flow through a chimney pipe **68** into vapor collecting pipe **38** in which they are mingled with solvent vapors recovered from the chambers **10** and **40** and pumped by a pump **69** to a condenser **70** where they are condensed to liquid form. The condensed, purified solvent liquid is recirculated to the containers **60** through pipe **72** and valved branch inlets **74** by pump **71**, either directly as shown, or through one or more oil scrubbers.

The grease and other impurities separated from the solvent in distiller **66** may be withdrawn periodically through a suitable piping system (not shown).

Figs. 3 and 4 of the drawing show in more detail one form of worker roller mechanism suitable for the cleaning apparatus and method of the invention, the worker rollers in this instance having the preferred lateral or endwise reciprocal working or rubbing movement.

As shown in these figures, the roller mechanism has a bed frame **100** at the ends of which are vertical supports **102** (Fig. 3) having tubular upper ends on which are slidably mounted the ends of an upper frame **104**. Frame **100** has fixedly mounted thereon transverse rods **106** on which is slidably mounted, by means of collars **108** a lower roller carrying subframe **110**. Similarly, frame **104** has fixedly mounted thereon transverse rods **112** on which is slidably suspended, by means of collars **114**, an upper roller carrying sub-frame **116**. The upper and lower banks of working rollers **118**, which correspond to those diagrammatically indicated at **20** in Fig. 1, are mounted on shafts **120** which are rotatably journaled through the opposite side members of sub-frame **116**, **110**, respectively, and held therein by collars **122** at opposite sides of said members. The roller shafts **120** have fixed thereto, at one end, worm gears **124**. Rotatably journaled through supporting arms **126** fixed to the corresponding side member of the upper and lower sub-frames **116**, **110** are a pair of drive shafts **128** carrying worm gears **130** which mesh with the worm gears **124** of the upper and lower banks of rollers respectively. The upper drive shaft **128** has a driving sprocket **132** connected by chain **134** to a sprocket **136** on a main drive shaft or motor shaft **138** rotatably mounted on a lateral extension, above the sub-frame **104**, of a fixed vertical frame **140** at one side of bed frame **100**. Lower drive shaft **128** has a driving sprocket **142** connected by chain **144** to a second sprocket **146** on upper shaft **128**.

Also rotatably mounted on frame **140** is a shaft **148**, driven by sprocket and chain connection from shaft **138**, and carrying a crank disk **150** having pivoted thereto one end of a crank arm **152**. The other end of arm **152** is pivoted to a lever **154** pivoted between its ends on a shaft **156** fixed to frame **140**. A pair of levers **158**, **160** have one end pivotally connected to lever **154**, respectively, at opposite sides of shaft **156**. The opposite end of lever **158** is pivoted at **162** to sub-frame **116** while the lever **160** has its opposite end pivoted at **164** to sub-frame **110**.

Rotation of shaft **148** rocks lever **154** by means of crank arm **152** so that the levers **158**, **160** are reciprocated endwise in opposite directions, which in turn causes the sub-frames **110**, **116** and their banks of rollers **118** to slide to and fro, oppositely, on rods **106** and **112**, respectively, endwise or axially of the rollers **118**. Roller drive shafts **128**, being carried by the respective sub-frame **110**, **116**, remain in driving engagement with the roller worm gears throughout this endwise reciprocation so that the rollers are continuously rotated, the chain drive to the upper shaft **128** having sufficient flexibility to permit this movement without disturbing the drive.

The minimum spacing between the two beds of rollers is adjustable by means of adjustable stops **166** (Fig. 3) on the tubular upper ends of supports **102**, on which the upper frame **104**, which is slidable on said supports, rests. Said frame is yieldably urged against said stops by springs **168** surrounding the supports above the frame and bearing at opposite ends against the frame and against collars **170** adjustable on the supports.

The surface of the rollers **118** is kept clean by means of scrapers or brushes which remove dirt particles clinging to the rollers. As shown more particularly in Fig. 3, the rollers **118** of the lower bank are each provided with a flat, vertically arranged scraper blade **180** which is fixedly connected at its ends to frame **110** and disposed below the roller with its scraping knife edge closely clearing the under surface of the roller. The dirt scraped off the rollers by these scrapers falls into the solvent collecting basins below the rollers. The rollers of the upper bank are also provided with scrapers **182**, these, as shown in Fig. 3, being helically turned about the roller surface from their ends toward the middle so that their outer ends are below their central portion. This enables the dirt scraped from the roller surface to clear longitudinally of the scraper blades over their lower outer ends where it can drop into the collecting basins below the roller bed free of the layer of material being cleaned and of the lower rollers. Scrapers **182** may, as shown, be supported by connection at their ends to the frame **116**.

Rollers **118** may have smooth surfaces as shown, or they may be roughened as by the provision of longitudinal grooves, or both longitudinal and radial grooves, or by the provision of ribs.

While it is preferred to produce the working rubbing action upon the layer by an endwise oscillation of the rollers as by the mechanism herein specifically illustrated, a like effective action may be produced in other ways. For example, a similar effect may be produced by rotating successive rollers of the two banks in the feeding direction at slightly different peripheral speeds. This may be by rotating all the rollers of one bank at slightly slower speed than the rollers of the other bank but is better accomplished by rotating the rollers of the two banks at

variant speed within each revolution, as by an eccentric drive to the roller drive shafts, the variant drive to the two banks being out of phase. In either case, the effect is to produce a rubbing, scrubbing action on the surfaces of the layer oppositely in the direction of travel of the layer, instead of transversely thereof as with the mechanism shown.

It will be understood that by illustrating herein preferred forms of mechanism for practicing the process, I do not intend to limit the invention thereto, but only as may be required by the appended claims.

I claim:

1. The method of dry cleaning and degreasing a material of the nature of wool and other fibres and fibrous bodies, hair, skins, fur and fabrics with a dry-cleaning grease dissolving solvent which comprises continuously advancing the material in layer form through an elongated cleaning zone in a sinuous path and therein feeding solvent at a plurality of longitudinally spaced points through the layer and draining used solvent therefrom while at a plurality of points spaced longitudinally of the layer, subjecting the layer to simultaneous rolling squeezing and bending action and to simultaneous reciprocal transverse rubbing and scrubbing action relative to said advancing layer oppositely on its opposite surfaces.

2. Apparatus for cleaning and degreasing wool and other materials with a dry-cleaning, grease dissolving solvent which comprises in combination, means for supporting and continuously advancing a layer of the material including a first bed of rollers engageable with one surface of the layer and a second bed of rollers engageable with the opposite surface of the layer between rollers of said first bed, the beds of rollers being closely spaced and the adjacent rollers of the respective beds being closely spaced to squeeze the layer between the rollers of said two beds the rollers of said beds being disposed transversely of the path of travel of the layer, means for rotating said rollers to advance the layer therebetween, means for continuously oscillating all of the rollers of one of said beds endwise relative to adjacent rollers of the other said bed to exert transverse working pressure on the layer alternately in opposite directions and means connecting to a source of a said solvent under pressure for applying said solvent to a surface of the layer while the layer is acted on by said rollers.

3. Apparatus for cleaning and degreasing wool and other materials with a dry-cleaning, grease dissolving solvent which comprises in combination, means for supporting and continuously advancing a layer of the material including a first bed of rollers engageable with one surface of the layer and a second bed of rollers engageable with the opposite surface of the layer between rollers of said first bed, the beds of rollers being closely spaced and the adjacent rollers of the respective beds being closely spaced to squeeze the layer between the rollers of said two beds the rollers of said beds being disposed transversely of the path of travel of the layer, means for rotating said rollers to advance the layer therebetween, means for continuously oscillating all of the rollers of one of said beds relative to adjacent rollers of the other said bed to exert opposite working pressure on the opposite surfaces of the layer alternately in opposite directions, means connecting to a source of a said solvent under pressure for applying said solvent to a surface of the layer while the layer is acted on by said rollers, and means for removing dirt from the surface of said rollers.

MANFRED T. HOFFMAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
111,313	Brown	Jan. 31, 1871
125,548	De Forest	Apr. 9, 1872
174,047	Wilson	Feb. 22, 1876
220,208	Lockwood	Sept. 30, 1879
534,027	Anderson	Feb. 12, 1895
579,524	Turney	Mar. 23, 1897
657,407	Peltzer	June 4, 1901
899,399	Shuman	Sept. 22, 1908
899,440	Shuman	Sept. 22, 1908
1,006,726	Croston	Oct. 24, 1911
1,165,570	Craven	Dec. 28, 1915
1,861,490	Butterworth	June 7, 1932
1,934,749	Tingle	Nov. 14, 1933
2,196,695	Davies	Apr. 9, 1940