Aug. 29, 1972 L. E. WINBURN ET AL 3,687,729

METHOD AND APPARATUS FOR CLEANING MATERIALS

Filed April 17, 1969 2 Sheets-Sheet 1

FIG. 1.

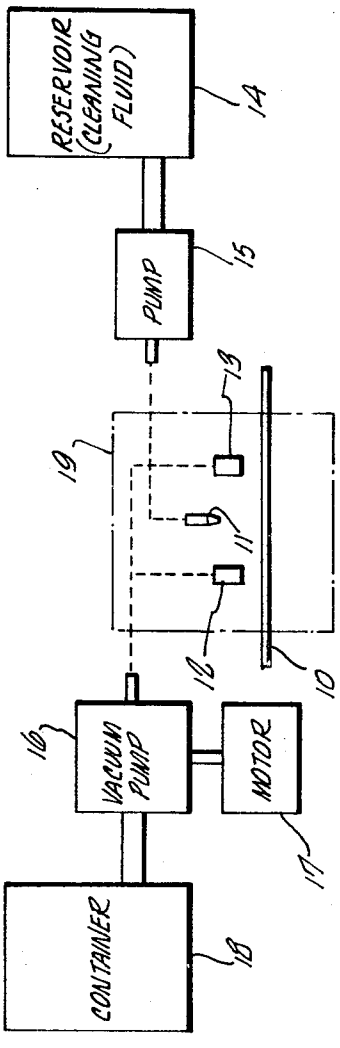
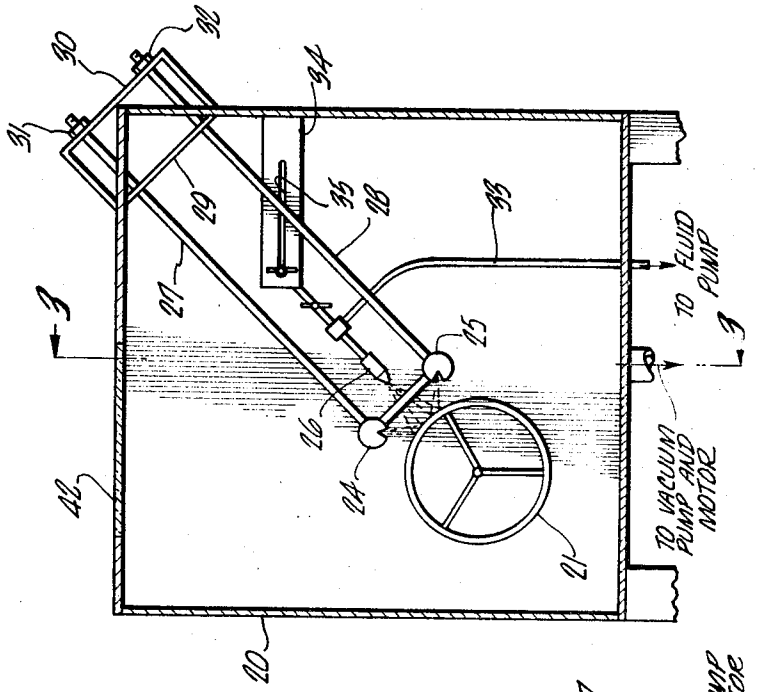


FIG. 2.



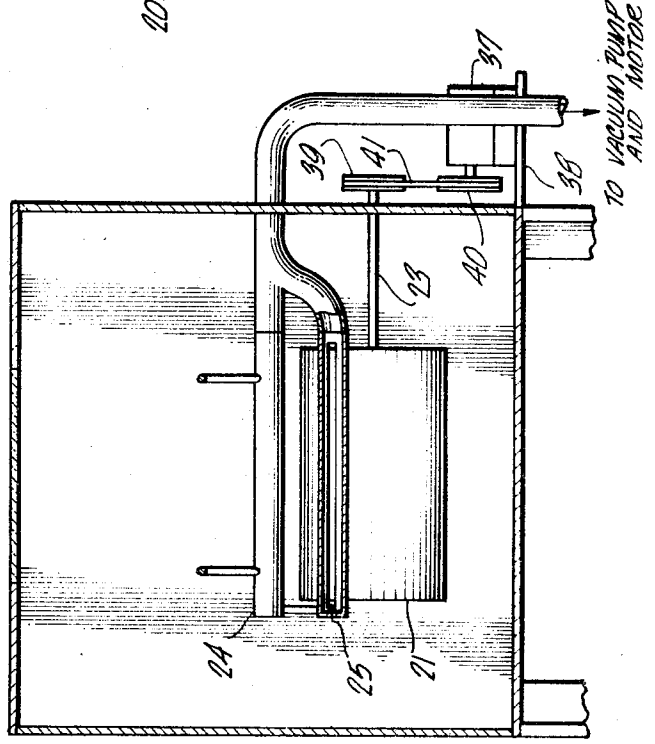


FIG. 3.

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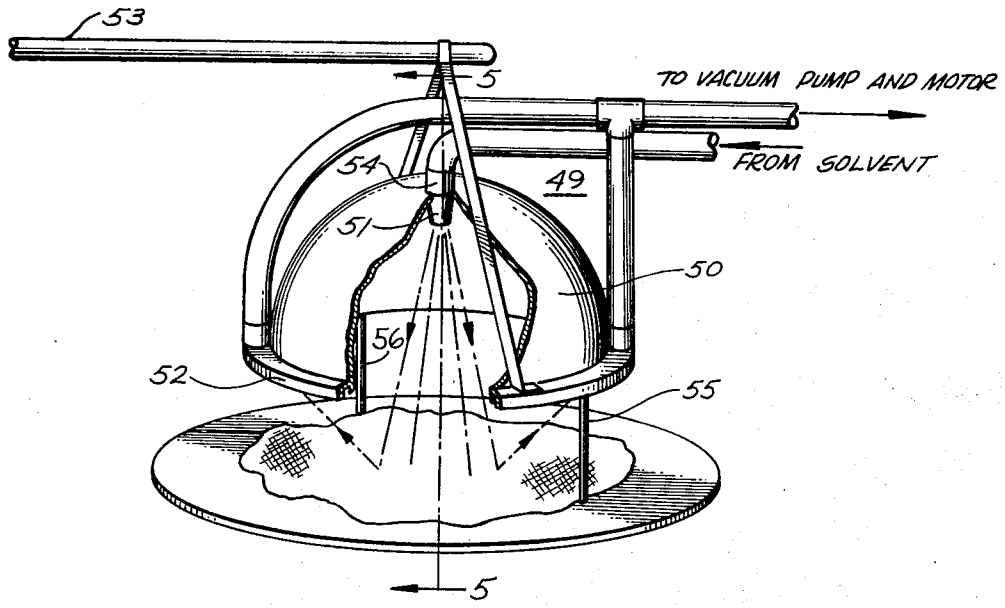


FIG. 4

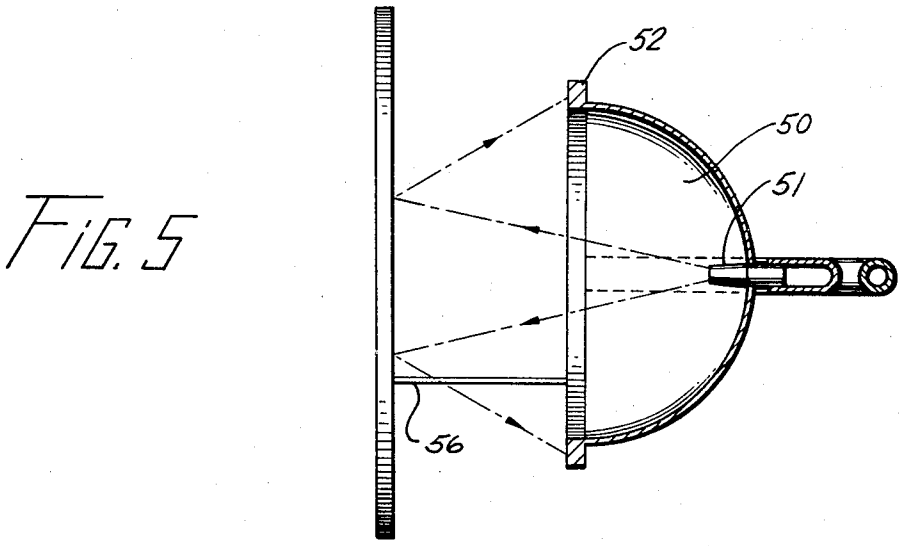


FIG. 5

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METHOD AND APPARATUS FOR CLEANING MATERIALS

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ABSTRACT OF THE DISCLOSURE

The method of cleaning the surface of an article comprises the steps of forcing molecular sized cleaning solvent against the surface at a high velocity and sucking off the solvent upon penetration or striking of the matter to be removed from the surface by the solvent molecules. The solvent may include a rare earth element, such as lanthanum, for improved cleaning of certain materials. The method and apparatus have particular application in the cleaning of fabrics and in particular the cleaning of fabrics or covering of articles having difficult to clean configurations such as the configurations of lamp shades.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to method and apparatus for cleaning the surface of an article without substantial wetting of the material of the article, and is particularly useful in cleaning materials in general, and more particularly in cleaning difficult to clean articles, such as lamp shades and articles of difficult to clean configurations that are covered with an easily disintegratable material if excessively moistened.

The method and apparatus for cleaning articles may be employed, for example, to remove coatings such as oxide coatings from metal surfaces, or, as another example, may be used to remove grease from a lamp shade by selection of the proper cleaning fluid used in the system.

SUMMARY OF THE INVENTION

The method of cleaning the surface of articles comprises the steps of selectively spraying a cleaning fluid under a high pressure, with the cleaning fluid being broken up into gaseous molecules, against the matter to be removed from the surface of the article, reversing the direction of travel of the gaseous molecules substantially at the surface of the article and after impingement upon or penetration of the matter to be removed from the surface of the article, and removing the cleaning fluid and the loosened matter from the article by suction.

In one particular application the fluid may be forced against the surface of the article to be cleaned by using a nozzle having a small opening, for example an orifice of .005", and with a pressure at the orifice of the nozzle of approximately 4000 pounds per square inch. For the dry cleaning of wearing apparel, draperies, furniture, etc. the cleaning fluid may be advantageously an organic solvent such as perchloroethylene or any of the other commonly-used dry cleaning solvents.

Another cleaning fluid that is particularly useful in applicants' method includes one of the rare earth elements as an additive. In particular, the rare earth element lanthanum is used in combination with helium, hydrous sodium borate, and a hydrocarbon such as toluene, to

form an excellent solvent with the heavy element increasing the ability of the solvent to loosen the material to be removed from the surface being cleaned.

The apparatus for removing material from a surface comprises a reservoir of cleaning fluid, a nozzle selectively directed toward the surface to be cleaned, a means for forcing the fluid from the reservoir up to and through the nozzle, a vacuum head positioned to suck up the fluid after it strikes the material to be removed from the surface to be cleaned, a vacuum pump operatively connected to the vacuum head, and a motor to drive the pump.

The apparatus may further include a reservoir at the output of the vacuum pump for collecting the spent cleaning fluid and the material removed from the surface, a filter for removing the foreign matter from the cleaning fluid, and a pump operatively connected between the reservoir and filter for pumping the fluid through the filter and back to the main reservoir of cleaning fluid. The nozzle of the apparatus may advantageously have an orifice of .005" and the means for forcing the fluid from the supply through the nozzle may advantageously be an air pump that produces an output pressure of approximately 2600 pounds per square inch.

Additionally, the nozzle and vacuum head may advantageously have a common mounting that is lightweight and can be moved over an area independent of the reservoir and pumps, so that the apparatus may be used, for example, to clean drapes while hanging in the home, furniture and other things to be cleaned without removing them to a special location. The apparatus is thus advantageously portable so that its versatility is greatly enhanced over the apparatus that is generally found in a dry cleaning plant for example.

The elements of the apparatus may be configured for the cleaning of articles having configurations that make them difficult to clean. In this regard, the apparatus and method are particularly useful where the material of the article to be cleaned cannot be subjected to a soaking or a great amount of moisture. Such an article is a lamp shade, and the method and apparatus are therefore particularly useful in cleaning lamp shades which have heretofore generally been replaced rather than cleaned. For cleaning lamp shades, for example, the apparatus further includes a vacuum head that has a pair of elongated portions with openings that extend parallel to the longitudinal axis of the lamp shade. The apparatus may also include a means for rotating the lamp shade about its longitudinal axis to facilitate the cleaning thereof. The nozzle advantageously extends between the two portions of the vacuum head along a line parallel to the longitudinal axis of the lamp shade so that the cleaning fluid will be sprayed along the entire length of the shade. However, the nozzle may also be designed to provide a more localized pattern of spray, if it is so desired.

The above and other features and advantages of this invention may be understood more fully and more clearly upon consideration of the following specification and drawings, in which:

FIG. 1 is a schematic illustration of the system for cleaning the material of an article incorporating the method and apparatus of the present invention;

FIG. 2 is an end elevation view of an apparatus in accordance with the present invention having particular applicability to cleaning of lamp shades;

FIG. 3 is a cross-sectional view taken along the lines 3—3 of the apparatus of FIG. 2;

FIG. 4 is a top plan view of one possible embodiment of a portable working head of the apparatus in accordance with the present invention; and

FIG. 5 is a cross-sectional view of the working head of FIG. 4 taken along the section lines 5—5 of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The system for cleaning articles of the present invention is diagrammatically shown in FIG. 1 wherein the article **10** to be cleaned may be either stationary or have relative movement with respect to the cleaning apparatus. The cleaning apparatus includes a means for forcing a cleaning fluid toward the surface of the article **10** to be cleaned, which forcing means is diagrammatically shown in FIG. 1 as a nozzle **11**.

The cleaning fluid and the material to be removed from the surface of the article **10** which is loosened by the cleaning fluid, is removed from the surface by suction means such as the vacuum heads **12** and **13** which are diagrammatically shown in FIG. 1. The article **10** and the nozzle **11** and vacuum heads **12** and **13** may be enclosed in a chamber **19** as illustrated by dashed lines around these elements.

One theory of operation of the system of the present invention using parameters of an actual test, is as follows:

The cleaning fluid is forced through the opening in the nozzle **11** which opening may be for example .005" in diameter under a pressure of approximately 4000 pounds per square inch at the nozzle. The cleaning fluid at this pressure is in the form of a gas that has an average droplet size of approximately five microns in diameter. Several million of the gaseous molecules of cleaning fluid are forced in a controlled direction with the minute particles of the fluid being in vigorous motion. The gas molecules move with a high average velocity and cause pressure by their impact against the material to which they are directed. It is believed that the gas moelcules have an average velocity of approximately fifty feet per second and that these gas molecules of the cleaning fluid penetrate nearly all molecules of ten micron diameter or greater. The kinetic energy of these gas molecules is very high at the time of impact upon the molecules of matter to be removed from the surface of the article being cleaned. The direction of these gas molecules is reversed by the vacuum suction and it is believed that this reversal most advantageously takes place at the instant the gas molecule penetrates the foreign molecule.

The inches of mercury that the vacuum will raise is controlled to the point where the vacuum suction is sufficient to reverse the direction of the high velocity cleaning fluid gas molceule. It is believed that upon this reversal, the motions of the material bodies produce a physical and chemical change so that heat is induced by the energy of separation. It is also believed that some of the gas molecules that penetrate the foreign substance molecules become resonant so that a tremendous amount of energy is added to the kinetic energy force and a small explosion at the surface of the article to be cleaned takes place.

Additionally, it is believed that as atoms in the high speed gas molecules collide with each other ionization takes place to increase the molecular attraction between the molecules of the cleaning fluid and the foreign unwanted molecules. Thereafter, the combined gas molecule and molecule of foreign matter as well as the otherwise loosened foreign matter and the other gas molecules are drawn into the vacuum heads **12** and **13**.

The system has particular application in removing oil, grease, and hydrocarbon particles as well as other water insoluble matter from wearing apparel, upholstered furniture, decorative drapes, lamp shades, rugs, paper, metal, etc.

Apparatus to be used in conjunction with the nozzle **11** and vacuum heads **12** and **13** are shown in block form in FIG. 1. The cleaning fluid is contained in a reservoir **14** and is supplied to the nozzle **11** by the operation of a pump **15**.

In one particular application of the invention, a pump manufactured by the Alemite Division of the Stewart-Warner Corporation was employed as pump **15**. This pump

is the Alemite Model 707–H, which is an air-operated unit which develops an output pressure of 2600 pounds per square inch with an input air pressure from a compressor of 100 pounds per square inch. This pump was used with a nozzle manufactured by Spraying Systems Co., which nozzle carries the identification No. 24 AUA Autojet. This particular nozzle is an air-triggered gun that has a maximum operating pressure of 4000 pounds per square inch. This particular nozzle has an orifice of .005" in diameter, and when positioned approximately twelve inches from the article to be cleaned, produces a spray pattern on the surface of the article approximately six inches in diameter.

The apparatus further includes a vacuum pump **16** driven by motor **17** with the vacuum pump being coupled to a container **18** for collecting the output of the vacuum pump.

In one configuration of the system, as an illustrative example, the vacuum heads **12** and **13** were joined together and formed a circle around the nozzle at a position near the surface of the article **10** that was being cleaned. The vacuum heads were placed at approximately two inches from the surface of the article **10** and when joined together formed a circle having a diameter of approximately eight inches. A vacuum pump **16** was employed which operated at a pressure of approximately twelve inches of mercury at room temperature.

When employing a cleaning fluid of perchloroethylene and the above-described elements positioned at the noted locations, the system readily cleaned heavy grease from the article being cleaned with negligible dampening of the article taking place. This system is thus a very efficient system for dry cleaning articles since it eliminates the general multi-step process that is employed in most commercial cleaning plants, which steps are washing the article in a non-aqueous solvent, draining the excess solvent, centrifuging the article to remove the solvent therefrom by centrifugal force, and thereafter drying the goods with hot air to remove the residual solvent therefrom. Not only does applicants' system reduce the number of steps and the time involved in cleaning an article, but it has the further advantage that very little cleaning fluid, which may be a dry cleaning solvent for example, is lost to the atmosphere and consequently there is very little hazard to anyone operating the system.

Applicants also devised and employed a solvent that has improved characteristics over the common dry cleaning solvent, such as perchloroethylene, when used in applicants' system, which is diagrammatically shown in FIG. 1. The improved solvent includes a relatively heavy element taken from the rare earth elements, and in particular the lanthanum element thereof. The base solvent is comprised of helium, hydrous sodium borate, and a hydrocarbon, such as toluene for penetration of fossil fuel base type matter to be removed from the article. The improved solvent has a total atomic number of 307 and an atomic weight slightly greater than 596, and is thus a relatively heavy liquid compared to a liquid such as perchloroethylene.

A particularly perplexing cleaning problem in the past has been the cleaning of lamp shades. Lamp shades are made of many materials and some are relatively expensive. Absent an effective way to clean the shades, it has been necessary to replace the shades, some of which are relatively expensive. Applicants' system, however, may be advantageously used to clean lamp shades, and an apparatus for such cleaning is shown in FIGS. 2 and 3 of the drawing. The apparatus includes a chamber **20**, which may be enclosed to protect the operator of the system from any noxious fumes that may be present, when the usual type dry cleaning solvent is being employed. The lamp shade **21** is secured in the chamber **20** on a rotatable rod **23**. The rod may have a threaded end and cooperating wing nut (which are not shown) for securing the lamp shade thereon.

Adjacent the lamp shade at a selected distance therefrom are positioned vacuum heads **24** and **25** and nozzle **26**. The position of the vacuum heads **24** and **25** and the nozzle **26** in the chamber **20** are adjustable to accommodate different sizes of lamp shades. For example, vacuum heads **24** and **25** are supported by rods **27** and **28**, respectively, which rods protrude through the chamber **20** and are slidably held in place by brackets **29** and **30**. The rods **27** and **28** have threaded ends with cooperating nuts **31** and **32** to adjust the position of the vacuum heads **24** and **25** in the chamber. Other means of adjustment may be employed, and the means shown in FIG. 2 is merely illustrative.

The nozzle **26** has a hose **33** connected to it for supplying the cleaning fluid. The connection of the hose **33** to the fluid pump is not shown, but it would be connected as diagrammatically shown in FIG. 1. The nozzle **26** is supported by bracket **34** which has a slot **35** therein in which the nozzle is slidably mounted so that its position may be adjusted within the chamber **20** to accommodate various sizes of lamp shades. Again, the means for mounting the nozzle is merely illustrative and may be any suitable means.

As the lamp shade **21** is cleaned it is rotated in the chamber so that all sides will be subjected to the cleaning fluid sprayed thereon through the nozzle **26** and removed therefrom through the vacuum heads **24** and **25**. The means for rotating the lamp shade is shown more clearly in FIG. 3 which is a cutaway side view of the apparatus of FIG. 2 taken along the section lines 3—3 of FIG. 2.

As shown in FIG. 3 a motor **37** is mounted on an extention **38** at the back of the chamber **20**. The motor drives the rod which supports the lamp shade, through a pulley **39** at the end of the rod **23** and a pulley **40** connected to the shaft of the motor **37**. The pulleys are operatively connected by a belt **41** so that the lamp shade **21** is rotated by the action of the motor **37**.

The vacuum heads **24** and **25** extend along the length of the lamp shade **21** on lines parallel to the longitudinal axis of the lamp shade which axis is also the axis of rotation of the lamp shade. The nozzle **26** may have a single orifice and provide a circular pattern of fluid sprayed on the lamp shade, or it may be a series of nozzles having single orifices spaced along the length of the lamp shade so that the entire length of the lamp shade is sprayed with cleaning fluid. Alternatively, an elongated pipe with many orifices along the length of the lamp shade may be used as the nozzle. A window **42** may be provided in the top of the container so that the operation of the apparatus may be observed.

The system for cleaning articles readily lends itself to portability so that articles may be cleaned without removing them from their place of utilization. For example, if the system is being used for cleaning articles that are normally dry cleaned, it may be used to clean drapes while hanging on the wall, overstuffed or upholstered furniture, wall-to-wall carpets, and automobile upholstery, without removal from their fixed position, and for many other similar cleaning jobs. For this purpose, the cleaning fluid reservoir and cleaning fluid pump may be mounted on one portable chassis while the vacuum pump motor and residue container are mounted on another chassis, or these elements may be mounted on a single chassis which may be readily movable on wheels. Thereafter, the working head which supports the nozzle and vacuum heads may be made relatively lightweight with flexible connections to the other elements so that it may be readily and easily moved over the surface to be cleaned.

Such a portable working head **49** is shown in FIGS. 4 and 5. The portable working head **49** has a solid, rigid, hemispherical support **50**, similar to a mixing bowl, with

the nozzle **51** mounted at the apex of the hemisphere and the vacuum head **52** mounted around the outside circumference at the open end of the bowl-shaped supports **50**.

To the hemispheric support **50** is attached a telescopic handle **53** through a strap **54** which may be rigidly attached to the head **50**. If it is desired to keep the working head a fixed distance from the article being cleaned, gauges **55** and **56** may be attached to the working head **49** wherein the ends of the gauges will contact the article to be cleaned and the working head can be easily kept at a fixed distance from the article.

Various changes may be made in the details of construction without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. Apparatus for cleaning lamp shades comprising a container, means for rotatably mounting the shade in said container, a nozzle mounted in the container a selected distance from the lamp shade, a vacuum head having two suction means extending parallel to the longitudinal axis of the lamp shade and on opposite sides of the nozzle, a reservoir for solvent, means for forcing the solvent in said reservoir through said nozzle, and means cooperating with the vacuum head for sucking the solvent that strikes the surface of the lamp shade into the vacum head.

2. Apparatus in accordance with claim **1** wherein the nozzle produces a rectangular pattern with the long side parallel to the longitudinal axis.

3. Apparatus in accordance with claim **2** wherein the nozzle has an opening of .005 inch and is positioned approximately twelve inches away from the lamp shade, the vacuum head is positioned approximately two inches away from the shade and the suction means is operating at about twelve inches of mercury and the forcing means generates a pressure of approximately 4000 p.s.i. at the nozzle.

4. Method of removing material from a surface comprising the steps of forcing a solvent through a nozzle having an opening of .005" with a pressure at the nozzle of approximately 4000 pounds per square inch, and reversing the direction of travel of the solvent at the surface of the material by applying a suction created by a vacuum pump generating a vacuum of twelve inches of mercury.

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U.S. Cl. X.R.

8—137, 142; 15—302, 321, 322; 68—5 A, 5 B, 20; 134—33, 37, 149, 153