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VAPOR DEGREASING APPARATUS AND METHOD

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FIG. 1

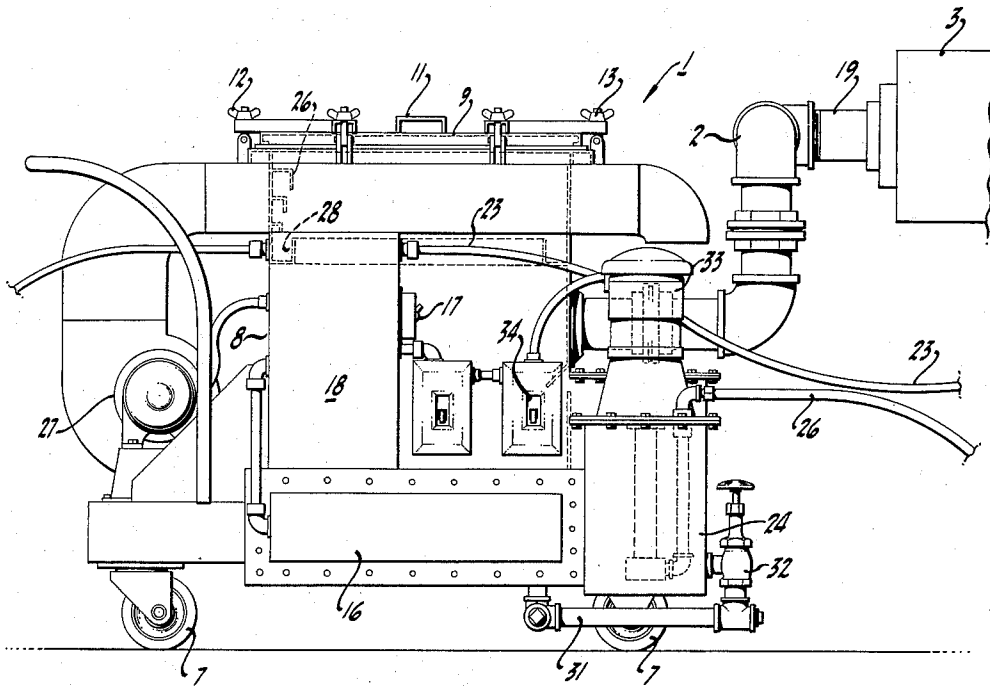
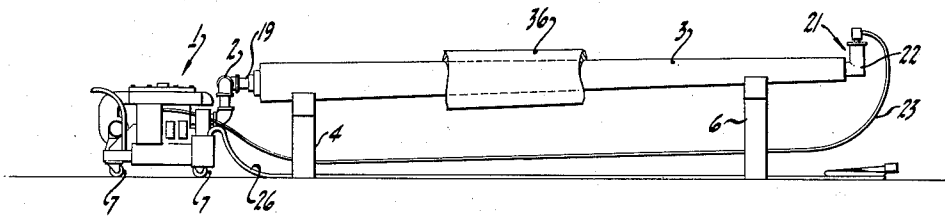


FIG. 2

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VAPOR DEGREASING APPARATUS AND METHOD

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5 Claims. (Cl. 134—22)

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This invention may be manufactured and used by or for the Government of the United States of America for governmental purposes without payment of any royalties thereon or therefor.

This invention relates to cleaning apparatus and more particularly to a method and apparatus for cleaning interior surfaces of tubular members, such as gun barrels and the like.

In the periodic maintenance and reactivation of stored gun barrels, it frequently becomes necessary to clean the gun bores to the extent that dirt, grease and any preservative coating is thoroughly removed, and, until the present invention, such scavenging was performed in a long and tedious manner involving the working of swabs to and fro in the barrels. Obviously, such a procedure was excessively time-taking, usually requiring about three man days to clean a 5" gun barrel and progressively greater periods to clean the larger guns. Also, occasions periodically arose when it is necessary to reactivate large numbers of these guns, and such a task became almost endless. As a consequence, other cleaning methods, such as the use of high pressure steam, were attempted, but these all were found deficient in some respect. For instance, the high pressure steam not only was dangerous to use, but it left a film of water on the bore surfaces such as became very conducive to subsequent rust formations.

It is therefore a principal object of this invention to provide an unusually expeditious manner and means for thoroughly scavenging the interior surfaces of a tubular object.

More specifically, other objects are to provide a method of cleaning by vapor condensation and recovery and to ensure a thoroughly dry and clean surface after such condensate has performed its work.

Further objects are to provide an automatic shut-off means for said vapor flow when said cleaning is completed; to provide easily portable cleaning apparatus operable in the manner stated in the above objects, and also to provide an apparatus and cleaning method that is entirely safe to personnel and requires a minimum number of such personnel to operate.

According to the practices of the present invention, the cleaning is performed by vaporizing a suitable degreasing and cleaning solvent, such as trichlorethylene or perchlorethylene, and then conducting this solvent vapor into, preferably, the breech end of the bore of the gun to be cleaned. As would be expected, when the hot vapor strikes the cold surfaces of the bore, it condenses and the apparatus is so arranged that the condensed vapor flows back into a sump or reservoir. Also, the continued supply of the hot vapor eventually heats the surfaces which it contacts to a point where the vapor no longer will condense, and, when these surfaces are so heated the vapor progressively moves on and condenses on contiguous colder surfaces of the barrel. This progressively moving condensation continues until the vapor has con-

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densed and heated all surfaces of the barrel and, most suitably, at that particular time a thermostat is actuated to shut off the vapor supply.

A further refinement of the invention which may be used if found desirable is a final flushing of the bore of the barrel by a cleaning liquid solvent which, if the barrel is inclined to permit a gravity flow, may be introduced at the high point of the barrel. Such a cleaning liquid solvent best can be obtained by providing some means, such as air-cooled vanes mounted at an upper level of the condensate sump or reservoir, to condense a certain portion of the vapor, this condensed portion being conducted by troughs or the like, to a separate flushing solvent reservoir from which it is delivered to the gun barrel.

One of the advantages of such a cleaning procedure is that the solvents completely dry in a short time after the application, so that the interior bore of the gun is left entirely dry and free from any tendency to rust. Another equally important advantage is that the cleaning is carried out automatically by a vapor flow which requires no high pressures and, in fact, requires no separate means for causing the vapor to circulate through the object being cleaned. In other words, the vapor simply progresses because it can no longer condense on a particular heated surface area, and the condensate return can be established simply by a gravity flow. Of course, if the situation should demand it, a circulating system could be employed particularly to ensure the condensate recovery.

The preferred embodiment of the invention is illustrated in the accompanying drawings of which Fig. 1 is a somewhat diagrammatic side elevation showing the cleaning apparatus operatively coupled to a 5"/38 gun barrel, and Fig. 2 an enlarged side elevation of the apparatus itself.

Referring to the drawings, Fig. 1 shows cleaning apparatus 1 operatively coupled by a flexible conduit 2 to the breech end of a 5"/38 gun barrel 3, this barrel being supported on suitable standards 4 and 6 which are of such relative height as to slightly elevate the muzzle end of the barrel. Further, it may be noted in Fig. 1 that the cleaning apparatus is mounted on suitable wheels 7 so as to be portable to the extent that it may be moved from one gun barrel to the next. However, it is also contemplated that cleaning apparatus of this type may be employed in a gun barrel re-preserving production line which, conceivably, would include several stations such as, first, this cleaning or degreasing apparatus, then a vacublast station, and finally a painting and re-preserving station. Such a line operation would materially speed up the presently tedious processes which are present when each job is undertaken.

The details of the cleaning apparatus are shown in Fig. 2 in which it may be noted that the apparatus mounts a rather large boiler or sump 8 adapted to receive the liquid solvent to be vaporized and, as has been stated, this solvent may be any composition capable of dissolving or cutting the grease and other preservative coatings which require cleaning. Access to sump 8 for introduction of the solvent is permitted through a hinged top lid 9 provided with a handle 11 and adapted to be dogged down in a sealed position by wing nuts and bolts 12 and 13. In practice, the solvent, which is to be heated to a vapor stage in which it can be transported to the gun barrel by flexible conduit 2, is filled only to a limited level in sump 8, and of course, this level is maintained below the outlet opening of conduit 2 leading from the sump. Preferably, a suitable liquid indicator gauge (not shown) is provided to enable the operator to determine this level. To heat the solvent to its vapor stage, a bank of electric heaters 16 is mounted below the sump and,

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most suitably, these heaters are controlled by an electric starter switch 17 mounted on a control box 18.

The operation of the apparatus thus far described should be rather apparent. When the starter switch is operated to energize the heaters, the solvent gradually passes into its vapor stage and, since it is contained in a vapor sealed reservoir, it is constrained to pass out through flexible conduit 2 and into the breech end of barrel 3. It will be necessary to provide a suitable adapter to couple conduit 2 to the barrel and the only requisite of such an adapter is that it be of sufficient size to permit the flow of vapor in one direction and return flow of the cleansing condensate in the opposite direction. As illustrated, an adapter 19 may be used for this purpose, and although special adapters may be constructed, it has been found that they most conveniently can be made from the shells used for the particular size gun being cleaned. When the vapor is admitted into the breech end of barrel 3, it immediately contacts the cold interior surface areas at this end and condenses on them. This condensate, being formed of a degreasing and cleansing solvent, is capable of scavenging these surfaces and, also, since the muzzle end of the barrel is slightly elevated, the condensate, along with the foreign matter, flows by gravity back through conduit 2 and into sump or boiler 8. Eventually, as will be appreciated, the surfaces immediately adjacent the breech end of the barrel become heated to such an extent the vapor no longer condenses upon them. When such occurs, the vapor then passes on to adjacent cooler surfaces where it condenses and performs its cleaning function. In this manner, the vapor is capable of progressing or moving throughout the length of the barrel and, when this point is reached, a suitable thermostatically-controlled shutoff means 21 (Fig. 1) is employed to stop the vapor flow. Preferably, this shutoff means is mounted on an upwardly extending elbow fitting 22 mounted in the muzzle end of the gun barrel, and it is electrically connected by conduit 23 to control box 18 in such a manner as to be capable of de-energizing electric heaters 16. One of the more obvious advantages of such an automatic thermostatic means is that it is capable of preventing escape to atmosphere of the solvent and, when a solvent which has any toxic nature is employed, the prevention of such escape is of considerable importance.

A further feature of the invention is that, once the vapor-condensate cleaning action is accomplished, provision is made for readily flushing out the interior of the bore with a clean liquid solvent. This clean liquid solvent is contained in the cleaning apparatus in suitable reservoir 24 into which another flexible conduit 25 is connected. Conduit 26 is of sufficient length to permit its insertion into the muzzle end of the barrel so that the solvent can be introduced into that end and returned by gravity through the inclined gun barrel to sump 8. Also, it is most desirable to obtain the clean liquid solvent by vaporization of the solvent contained in sump 8 and this may be accomplished by mounting suitable air-cooled condensation vanes 26 along the upper level of sump 8. As may be noted, these vanes are disposed in the path of a forced air draft created by a fan 27, and, as the vapor condenses on the vanes, it falls into a trough 28 which conducts the clean condensate into reservoir 24 through another conduit 31 and a suitable gate valve 32. Pressure for pumping the solvent through conduit 26 and into the gun barrel is provided by another pump 33 mounted on top of reservoir 24, this pump being controlled by a starting switch 34. In addition to providing pressure for the flushing line, pump 33 also may be used to empty boiler or sump 8 when it becomes necessary to clean out such sludge and residue as may be accumulated in it.

The advantages of the present apparatus have been discussed earlier, but in resume, they include among others the fact that a portable, compact and easily operated ma-

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chine is provided for thoroughly accomplishing a cleaning operation in a minimum time and with a minimum effort. Further, the manner in which the cleaning is accomplished is free from any hazard to personnel, and, also, it leaves a surface that is entirely dry and not prone to rust. The apparatus may be used on almost any size gun or other object, and it even has been anticipated that the apparatus would be suitable for cleaning 16" guns. One difficulty with such large jobs might reside in the fact that the greatly enlarged surface areas would cool so quickly or, in other words, that the heat of the vapor would dissipate so rapidly, that the vapor never would progress beyond a certain limited extent of the bore. If such should be the case, it would be desirable to provide a suitable insulating jacket, such as jacket 36 (Fig. 1), for the barrel or, it would be possible to clean the barrel first by introducing the vapor into the breech end and then into the muzzle end. Such an operation would involve cleaning one-half of a barrel at a time and it would not present any particular difficulties because of the portable nature of the equipment. Yet another advantage of the invention is that the barrel insulation jacket 36 also can be used to advantage in certain circumstances to provide some control for the rate to which the vapor progresses through the gun barrel.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. Apparatus for cleaning the interior surfaces of an open-ended elongate object, said apparatus comprising a boiler for containing a liquid solvent, means for heating the boiler to vaporize said solvent, a vapor conduit extending from said boiler into one of said object's open ends for directly introducing vapor into and progressing it through the object by boiler pressure, and thermostatic means operable in response to vapor heat in said object for controlling said boiler pressure sufficiently to arrest said vapor progress short of said object's other open end.

2. Apparatus for cleaning the interior surfaces of an open-ended elongate object, said apparatus comprising a boiler for containing a liquid solvent, means for heating the boiler to vaporize said solvent, a vapor conduit extending from said boiler into one of said object's open ends for directly introducing vapor into and progressing it through the object by boiler pressure, and thermostatic means operable in response to vapor heat in said object for controlling said boiler pressure sufficiently to arrest said vapor progress short of said object's other open end, said communication of said boiler with said object permitting a return flow of the vapor condensate directly from the object into said boiler for re-use.

3. Apparatus for cleaning the interior surfaces of an open-ended elongate object, said apparatus comprising a boiler for containing a liquid solvent, means for heating the boiler to vaporize said solvent, a vapor conduit extending from said boiler into one of said object's open ends for directly introducing vapor into and progressing it through the object by boiler pressure, and thermostatic means disposed near said other open end of said object, said means being operable in response to vapor heat for controlling said boiler pressure and preventing vapor escape through said other open end.

4. A method of cleaning the interior surfaces of an open-ended elongate object comprising the steps of heating a liquid solvent to form a vapor heavier than air, supporting said object in an upwardly-inclined disposition, constraining said vapor to flow into the lower open end of the object, coordinating said vaporization heat with the condensation rate of said vapor on said surfaces for effecting gradual progress of the vapor through said object, and thermostatically utilizing said vapor heat for reduc-

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ing said heat supply sufficiently for stopping said vapor progress short of said upper open end.

5. A method of cleaning the interior surfaces of an open-ended elongate object comprising the steps of heating a liquid solvent to form a vapor heavier than air, supporting said object in an upwardly-inclined disposition, constraining said vapor to flow into the lower open end of the object, coordinating said vaporization heat with the condensation rate of said vapor on said surfaces for effecting gradual progress of the vapor through said object, returning said condensed vapor directly from said surfaces to said heater for re-use, and thermostatically utilizing said vapor heat for reducing said heat supply

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sufficiently for stopping said vapor progress short of said upper open end.

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