April 22, 1969 E. ZADRON ET AL 3,439,689

JET CLEANING APPARATUS WITH FILTER MEANS FOR REMOVING DEBRIS FROM THE CLEANING FLUID

Filed Sept. 30, 1966 Sheet 1 of 2

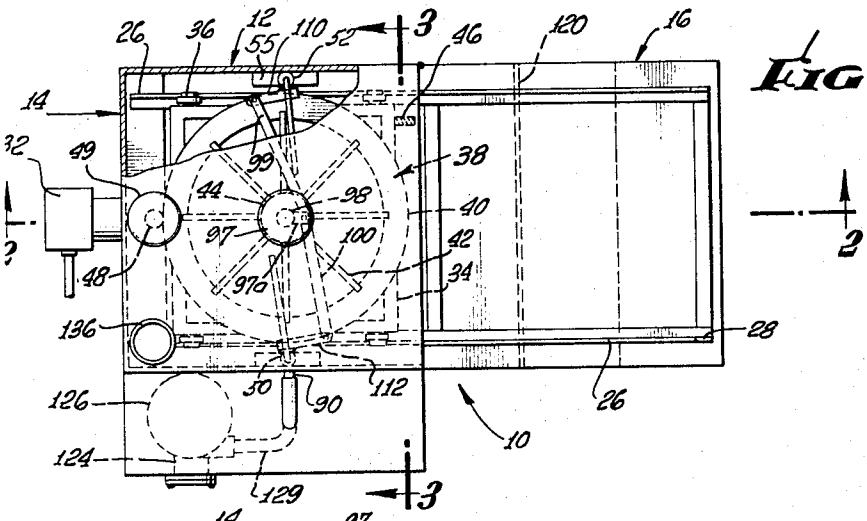


FIG. 1.

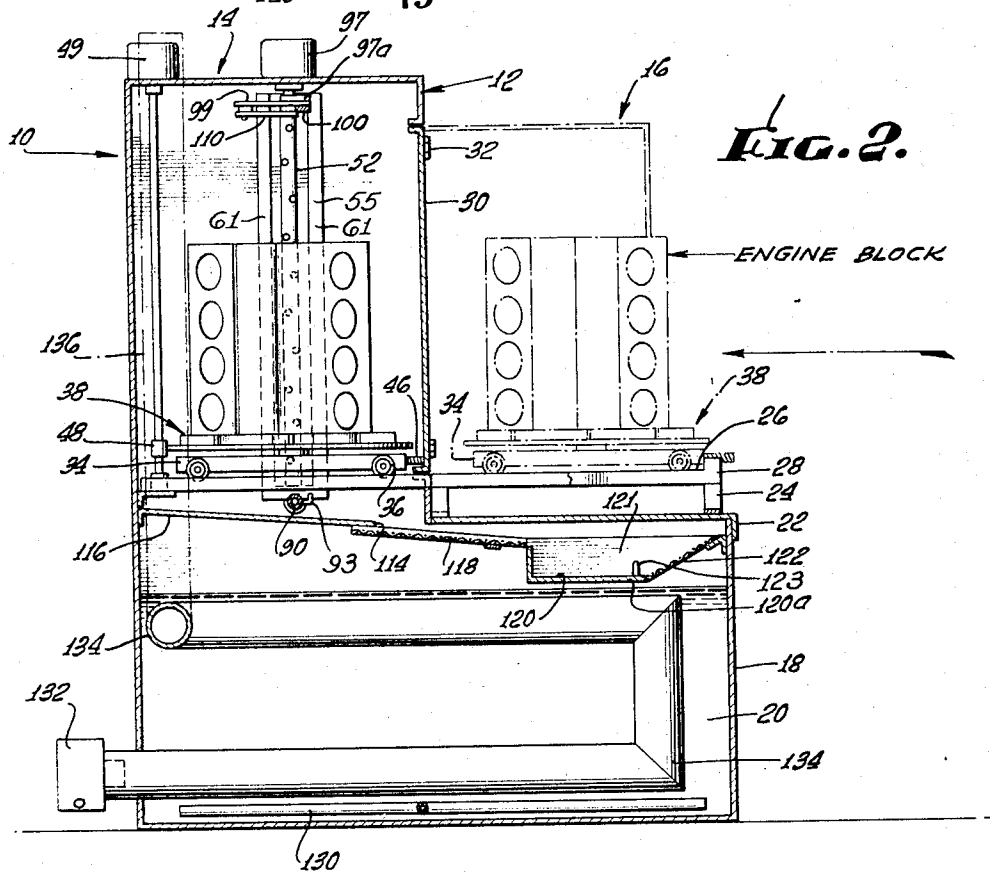


FIG. 2.

INVENTORS.
EMIL ZADRON
ALTON S. KENMONTH
By Their Attorneys.
HARRIS, KIECH, RUSSELL & KERN

April 22, 1969 E. ZADRON ET AL 3,439,689

JET CLEANING APPARATUS WITH FILTER MEANS FOR REMOVING DEBRIS FROM THE CLEANING FLUID

Filed Sept. 30, 1966 Sheet 2 of 2

FIG. 3.

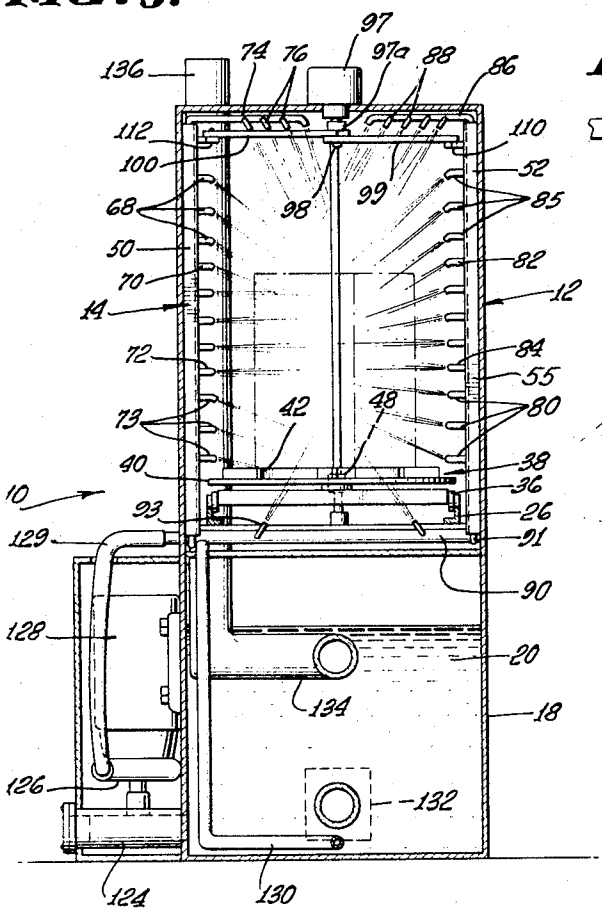


FIG. 4.

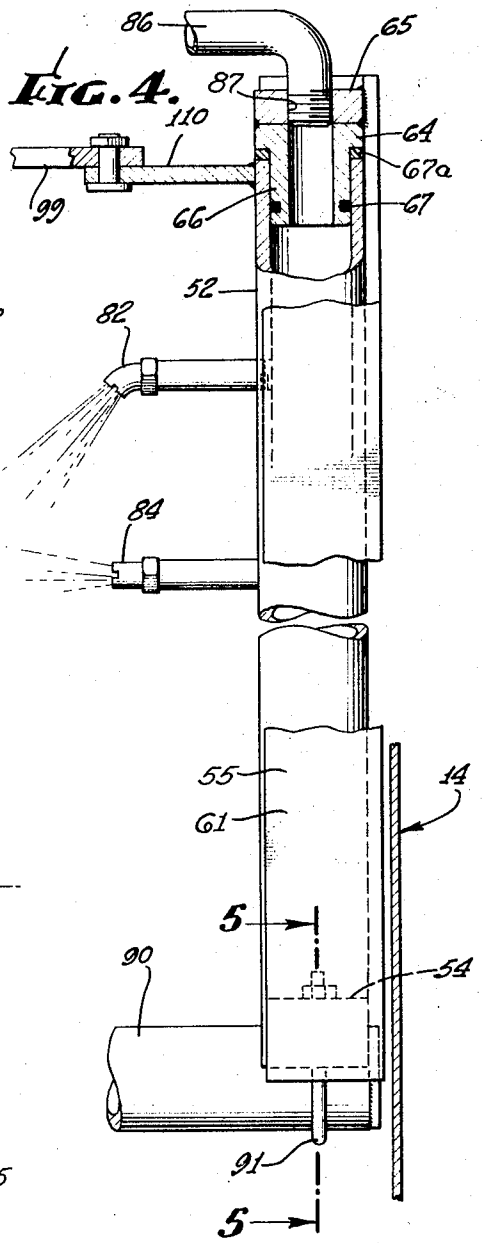
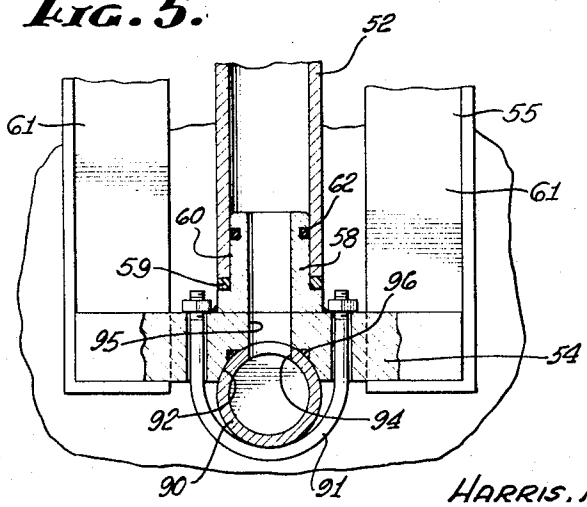


FIG. 5.



INVENTORS.
EMIL ZADRON
ALTON S. KENMONTH
By Their Attorneys.
HARRIS, KIECH, RUSSELL & KERN

United States Patent Office 3,439,689 Patented Apr. 22, 1969

3,439,689

JET CLEANING APPARATUS WITH FILTER MEANS FOR REMOVING DEBRIS FROM THE CLEANING FLUID

Emil Zadron and Alton S. Kenmonth, Los Angeles, Calif., assignors to Jet-Clean Co., a limited partnership (of California), Los Angeles, Calif.

Filed Sept. 30, 1966, Ser. No. 583,184
Int. Cl. B08b 3/02
U.S. Cl. 134—104 5 Claims

ABSTRACT OF THE DISCLOSURE

A jet cleaning apparatus having a cleaning chamber and a sloping wall positioned directly beneath the cleaning chamber. The uppermost zone of the sloping wall is imperforate so that cleaning fluid falling thereon flushes material removed from an article being cleaned onto a filter comprising the lowermost zone of the sloping wall. Most of the cleaning fluid and fine sediment return to a reservoir below the sloping wall through this filter, larger particles and the remainder of the cleaning fluid passing over the lower edge of the filter means into a debris trap. The trap is provided on the side thereof opposite the lower edge of the first-mentioned filter with a second filter sloping upwardly from the bottom of the trap, the remainder of the cleaning fluid returning through the reservoir through this second filter.

Background of invention

This invention relates to a means for cleaning objects. More particularly, the present invention relates to a means for cleaning irregularly shaped objects, such as engine blocks. Apparatus is provided which is particularly adapted for the cleaning of engine blocks and the components thereof, but it should be understood that other objects can also be cleaned with such apparatus. For example, carburetors, crankshafts, cam shafts, connecting rods, oil pans, valve covers, plates, castings, and other workpieces can also be cleaned with the apparatus provided by this invention.

The apparatus of the present invention in an exemplary embodiment is principally characterized by a housing into which the objects to be cleaned are placed. A wheeled carriage, rollable along a track, is provided so that large or heavy objects may be easily positioned within the housing. One or more oscillating headers equipped with nozzles are provided in the housing and the nozzles jet heated cleaning solution upon the object or objects to be cleaned, the objects being rotated on a spoked ring while being cleaned. The cleaning solution is stored in a tank or reservoir to which it is returned after striking the object or objects being cleaned, and thereafter the solution is recirculated to the headers. Successive objects may be cleaned with the recirculated solution.

Summary and objects of invention

One important feature and distinct advantage of this invention is that a screen or filter is carried by the reservoir for efficiently filtering the cleaning solution which is being returned to the reservoir after impinging upon the object being cleaned. The screen or filter traps larger particles of dirt and other debris on the top thereof, while allowing liquid and smaller particles of debris to pass readily therethrough. Preferably, the screen or filter is positioned in an oblique or slanted plane, the slanted screen providing a substantial measure of self-cleaning action. The screen is preferably not immersed in the circulating cleaning solution in the reservoir, and thus does not tend to readily plug up. The filter should preferably

cover the entire opening or drain which serves as a port for the return to the reservoir of cleaning solution which has been jetted through the nozzles in the headers.

Another important feature of the invention is that cleaning the reservoir of debris is simply and efficiently accomplished. For example, the operator can merely attach a hook used to hoist motor blocks and baskets to a handle on the reservoir, then tilt the tank or reservoir and allow the spent cleaning solution to run out of the tank. A slanted screen carried by the tilted side of the reservoir is preferably provided, so that the cleaning solution passes through the screen, and the debris which thereafter remains in the reservoir is practically dry and can be easily removed and disposed of.

In addition to the foregoing features, the present invention provides other important improvements over the prior art and overcomes many difficulties which are inherent in the cleaning of irregularly shaped objects such as engine blocks. For example, engine blocks contain many cavities which are difficult to clean by conventional cleaning devices, particularly without continuous adjustment thereof. Thorough cleaning of engine blocks is made still more difficult by the many different kinds of foreign matter which may be adhered thereto, such as carbon deposits, baked-on engine oil varnish, paint, grease, sand, and ordinary road dirt, and the like. Thus, an engine block cleaning device should be capable of removing most or all of the foregoing debris. Such a device is provided by this invention.

Another problem is presented by certain cleaning fluids which are effective to remove at least some of said debris but which when mingled with oil and greases often form a soap and tend to foam, thereby making them more difficult or impossible to pump under pressure to the spray nozzles of the cleaning device. The present invention overcomes the foregoing problem.

Yet another difficulty which is solved by this invenvention is in the handling of heavy objects during the cleaning operation.

Thus, it is a primary object of this invention to provide a cleaning apparatus which will automatically clean an irregularly shaped object, such as an engine block, without manual adjustment of the components of the apparatus. Handling of heavy objects being cleaned, other than loading and unloading them from the cleaning apparatus, is eliminated.

A further object of ths invention is to provide a cleaning apparatus which will thoroughly remove most or all of the above-noted deposits frequently found on engine blocks.

A further object of the invention is to provide a cleaning apparatus which will clean irregularly shaped objects much more rapidly than was possible heretofore.

Another object of this invention is to provide a cleaning apparatus which will rapidly and automatically clean all parts of an irregularly shaped object by causing jets of cleaning fluid to impinge against the object at varying angles and in overlapping paths.

A further object of this invention is to provide a cleaning apparatus which will impinge at least one jet of cleaning fluid against an irregularly shaped object along a line inclined with respect to a horizontal plane, and oscillate such jet through an arc along a path inclined with respect to the horizontal plane, and provide at least one revolution of relative rotation between the jet and the irregularly shaped object.

A further object is to utilize in the cleaning apparatus a generally vertical header having a plurality of nozzles secured thereto, at least some of the nozzles having axes which are inclined relative to a horizontal plane. By oscillating the header while rotating the irregularly shaped object the cleaning fluid is caused to impinge against the

object at varying angles and in overlapping paths so as to assure that substantially all portions of the object, including cavities therein, will be contacted and cleaned by the cleaning fluid.

A further object of this invention is to provide an engine block cleaning apparatus in which the forces exerted by high pressure oscillating streams of cleaning fluid against the engine block are substantially balanced. More particularly, the forces may be balanced, to some extent, by providing first and second rotatable headers on opposite sides of the engine block and a plurality of nozzles on each of the headers. By inclining some of the nozzles so that the fluid streams emitted by the nozzles of one of the headers generally oppose those emitted by the nozzles on the other of said headers, some force-balancing is produced. By oscillating the headers through a limited arc so that when the first header rotates in a clockwise direction, the second header rotates in a counterclockwise direction, and vice versa, additional force-balancing occurs. By use of such force-balancing means, the lateral forces acting on the engine block have a negligible effect on the relatively heavy block. Without such force-balancing, it could be necessary to anchor the engine block securely to a support member to prevent it from being moved or tipped within the cleaning apparatus, and additional driving force would be required to rotate the block.

The cleaning fluid generally used to clean engine blocks is a hot caustic material. Frequently, much of the foreign matter removed from the engine block is in the form of oil or grease deposits. In this invention the hot caustic is sprayed against the engine block to remove the oily deposits (and particles of debris) and then the mixture of hot caustic and the grease and oils, or a portion thereof, and particles which have been removed, are fed onto an obliquely extending filter. As the mixture passes on, over, and through the filter, the larger particles of debris, such as relatively large metal particles, are trapped on the upper surface of the filter and the relatively smaller particles are permitted to pass through the filter, together with at least a portion of the remaining mixture, and thereafter into the reservoir.

The obliquely extending filter to a large extent has a self-cleaning action, since it is slanted and the debris thereon tends as it accumulates to move down the inclined filter. At the lower end of the inclined filter means can be provided for accumulating the large particles, such as by providing a basin-like member, one side of which is provided with a second obliquely extending filter, the two filters being preferably inclined toward each other.

A further object, therefore, is to provide a self-cleaning obliquely-extending filter such as the one described above.

A further object is to provide a second obliquely-extending filter such as the one described above.

Distinct advantages are provided by this invention in the preferred embodiment of using two such filters. For example, the larger particles can be accumulated in the basin-like member and readily removed. The screens, if required, may be readily removed or replaced. In addition, when it becomes necessary to discharge spent cleaning fluid from the reservoir, to clean the reservoir, and to replace the spent cleaning fluid with fresh cleaning fluid, the reservoir can be merely tipped in the direction of the second filter and the spent cleaning fluid permitted to flow from the reservoir through the second filter. Upon removal of the second filter the debris remaining in the reservoir can be easily removed. The debris will generally be practically dry and easily disposed of.

Upon recirculating cleaning fluid which has been jetted against a workpiece and has been returned to the reservoir for recirculation to a jet spray means, a serious problem arises in the reservoir when the caustic cleaning fluid contacts and is mixed with the oil and grease deposits removed from the workpiece. Such contact produces a soap which forms a foam in the reservoir and which, if uncontrolled, may overflow the reservoir and may also cause a pump used for recirculating the fluid to cavitate. Further, it is desirable to heat the caustic material in the chamber thereby further aggravating the pump cavitation problem.

Accordingly, another object of this invention is to reduce the foaming of the cleaning fluid by dispersing the small particles of debris, described above, throughout the cleaning fluid. Thus, rather than letting the smaller particles settle to the bottom of the reservoir, it is desirable to agitate the fluid and disperse the smaller particles throughout the fluid. It has been found that such dispersion of the smaller particles eliminates the foaming problem.

A particular object of this invention is to eliminate the foaming of the cleaning fluid by disposing a perforated pipe within the reservoir and connecting the pipe to recirculate a portion of the cleaning mixture to the reservoir to hydraulically agitate the fluid contained therein. In addition to eliminating the foaming problem, such agitation disperses the small particulate matter throughout the cleaning fluid so that it can be pumped through the jet nozzles along with the cleaning fluid to act as an abrasive cleaning agent.

The workpiece is generally cleaned by hot caustic cleaning fluid. The cleaning action is improved as the temperature of the caustic solution is increased and is made still more effective by jetting the hot caustic against the workpiece under high pressure. However, increasing the temperature of the hot caustic reduces the vapor pressure of the cleaning fluid, thereby reducing the threshold of cavitation of the pump. Thus, it is important to maintain the temperature of the hot caustic.

A further object of this invention is to provide a compact package workpiece cleaning apparatus including a housing having a reservoir for holding cleaning fluid and a cleaning section communicating with the reservoir through an opening in the cleaning section; a plurality of nozzles within the cleaning section for directing streams of the cleaning fluid against the workpiece to remove particles, grease, oil, and/or soil therefrom; means for pumping the cleaning fluid from the reservoir to the nozzles; and means to permit the cleaning fluid directed against the object and the smaller particles removed therefrom to flow through a filter positioned in the opening and into the reservoir.

A further object of this invention is to provide a cleaning fluid-level gauge carried by the reservoir.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings.

Description of drawings

In the drawings:

FIG. 1 is a top sectional view of one embodiment of the cleaning apparatus of this invention, particularly illustrating in the upper portion of the apparatus means for oscillating a pair of opposite headers, and in the lower portion of the apparatus a spoked ring for supporting and rotating a workpiece to be cleaned;

FIG. 2 is a fragmentary sectional view taken along the arrowed line 2—2 of FIG. 1, particularly showing the cleaning section, the cleaning fluid reservoir, and a pair of obliquely extending filters of the cleaning apparatus;

FIG. 3 is a fragmentary sectional view taken along the arrowed line 3—3 of FIG. 1, particularly illustrating the details of the cleaning section of the invention;

FIG. 4 is a fragmentary sectional view of the details of a header of this invention and its components; and

FIG. 5 is a fragmentary sectional view taken along the arrowed line 5—5 of FIG. 4, particularly showing the details of the lower portion of the header of FIG. 4.

Description of exemplary embodiment of invention

Referring to the drawings and in particular to FIGS. 1 and 2 thereof, reference numeral **10** designates a cleaning apparatus which includes a housing **12** having a cleaning section or chamber **14** and an engine block or other workpiece loading section **16**. A tank or reservoir **18** for holding a cleaning fluid or solution **20** is provided below the cleaning section **14** and the loading section **16**.

The loading section **16** includes a lid or cover **22** which serves the dual functions of permitting access to the reservoir **18** and as a base for supports **24**. A track **26** is mounted on the supports **24** (FIG. 2), which track extends from the loading section **16** into the cleaning section **14**. The track **26** may be hinged or divided and slidably movable at or near the entrance to the cleaning section **14**. A stop **28** may be provided at the end of either one or both of the rails of the track **26**. As indicated earlier, the lid **22** also permits access to the reservoir **18**, the lid being slidably movable or hinged at its end proximate to the cleaning section **14** so that the lid may be opened and closed or removed.

Leading into the cleaning section **14** is a door **30** which may be provided with hinges **32** to permit entry and exit of a carriage **34** from the cleaning section.

The carriage **34** includes four wheels **36** and is mounted for movement along the track **26**. The carriage **34** also includes a rotatable support member **38**, which in turn includes a ring **40** and a plurality of spokes **42** extending radially inwardly from the ring and welded to a generally centered bushing **44**. One advantage of the support member **38** is that it is easily made and, therefore, is relatively inexpensive. In operation, the door **30** is opened and the carriage **34** is wheeled outside the cleaning section **14** and an engine block or other workpiece to be cleaned is placed on the support member **38**. Thereafter, the carriage **34**, with the workpiece, is wheeled into the cleaning section **14** and the door **30** is closed and secured. As the door **30** closes it presses against a spring **46** mounted on the carriage **34**, thus urging the carriage forward and positioning the carriage firmly in place within the cleaning section **14**.

As the carriage is urged forward into the cleaning section **14**, the ring **40** of the support member **38** engages a rotatable friction drive member **48** which provides means for rotating the support member and the workpiece mounted thereon. The drive member **48** may be coated with rubber or other material having a high coefficient of friction and is driven by a motor **49**.

Referring particularly to FIGS. 2 and 3, means is provided for emitting streams of the cleaning fluid **20** against the workpiece, generally an engine block, in the cleaning section **14**. Such means preferably includes two generally vertical headers **50** and **52** rotatably mounted to a base member or plate **54** of an elongated vertically oriented frame assembly **55** (FIG. 5) for oscillation about a generally vertical axis and disposed on opposite sides of the support member **38**, as shown in FIG. 3. Each of the headers **50** and **52** is rotatably mounted as illustrated in FIG. 5. A tubular member **58** is secured to the plate **54** and has an exterior portion **60** of reduced diameter for slidably and rotatably receiving an end of the header (header **52** being particularly illustrated). An annular washer **59** made of Teflon or the like is positioned between the header **52** and the tubular member **58** at the end of the exterior portion **60** to reduce friction between the rotating header and the tubular member. An annular sealing element **62**, such as an O-ring, is positioned between the header **52** and the tubular member **58**. The header **52** is allowed to oscillate relative to the seal **62** and the tubular member **58** and the seal **62** prevents fluid leakage between the header **52** and the tubular member **58**. The base plate **54** forms the bottom of the frame assembly **55** which also includes a pair of opposed vertically positioned L-shaped members **61** and an upper plate **65**. The frame assembly **55** is removably mounted to the housing **12** and within the cleaning section **14** by threaded bolts or screws (not shown). The entire frame assembly **55** including the header **52** is pre-assembled as a unit before mounting within the cleaning section **14**.

A similar rotary seal arrangement is located at the upper end of the header **52** (see FIG. 4). A tubular member **64** is secured to the plate **65** and has exterior portion **66** of reduced diameter for slidably and rotatably receiving the upper end of the header **52**. A washer **67***a*, similar to washer **59**, is located between the top of the header **52** and the tubular member **64**. An annular sealing element **67**, such as an O-ring, is positioned between the header **52** and the tubular member **64**. The header **52** is allowed to oscillate relative to the seal **67** and the tubular member **64** and the seal **67** prevents fluid leakage between the header **52** and the tubular member **64**.

The mounting of the headers **50** and **52** completely within frame assemblies **55** permits the headers to rotate with respect to the frame assemblies and, in effect, float therewithin. For example, all upwardly directed pressure on the headers **50** and **52** resulting from the surging of pumped cleaning fluid therewithin is transmitted to the frame assemblies **55** through the tubular members **58** and **64**.

Particularly referring to FIGS. 3 and 4, a plurality of nozzles **68** is threadedly secured to the header **50** and inclined downwardly at a given angle from a plane which is perpendicular to the longitudinal axis of the header, the plane being horizontal in the preferred embodiment. An angle of up to about 15° has been found particularly satisfactory. Preferably, all of the nozzles **68** extend downwardly at the same angle and are fixed relative to the header as no adjustment thereof is required. A special angle nozzle **70** may also be provided which extends downwardly at a different angle, and horizontal nozzles **72** may also be provided, or any suitable combination of the foregoing may be used. The nozzles **70** and **72**, if provided, should preferably be offset horizontally from the plane into which the nozzles **68** emit their jets in order to avoid interference therewith. The nozzles **70** and **72** may be provided to direct streams of the cleaning fluid into otherwise relatively inaccessible areas. A plurality of preferably upwardly inclined nozzles **73** may also be provided. The header **50** also includes a horizontal overhead pipe **74** which carries a plurality of nozzles **76** which are directed downwardly toward the workpiece. Preferably the nozzles **76** are inclined downwardly from a horizontal plane at an angle of about 60°.

The header **52** has a plurality of nozzles **80** directed upwardly preferably at the same angle at which the nozzles **73** are directed downwardly. The header **52** may also be provided, if desired or required, with a special angle nozzle **82**, corresponding to the special angle nozzle **70**, and/or horizontal nozzles **84**, corresponding to the horizontal nozzles **72**. Downwardly pointing nozzles **85**, corresponding to the nozzles **68**, may also be provided. The header **52** also may be provided with an overhead pipe **86** communicating with an opening **87** in the plate **65** and having a plurality of downwardly pointing nozzles **88**, corresponding generally to the nozzles **76**. There is substantially no distortion of the reservoir **18** and substantially no binding of the headers **50** and **52**.

Any of the foregoing nozzles may be of any suitable design and may constitute appropriate apertures in the walls of the headers **50** and **52**.

Inclining the nozzles **73** and **80** downwardly and upwardly at generally the same angle relative to their respective headers serves two important functions. First, providing nozzles at various angles insures that all cavities and other relatively inaccessible areas of the workpiece will be directly contacted by a stream of the cleaning fluid emitted from the nozzles. Secondly, the angular relationship between the nozzles **73** and **80** allows the nozzles **80** to emit fluid streams generally in opposition to the fluid streams emitted from the nozzles **73**; i.e., the

force exerted by the fluid streams from the nozzles **73** is substantially cancelled or balanced by the force of the jets emitting from the nozzles **80**. As the fluid streams emitted by the nozzles may be under high pressure, if this force-balancing effect is not provided then it may require considerably greater driving force to rotate the supporting member **38** and the workpiece. In addition, without such force-balancing, the respective fluid streams might tend to tip or move the workpiece within the cleaning section **14**.

A fixed manifold **90** connects the headers **50** and **52** with a source of cleaning fluid **20**. The manifold **90** is connected to the tubular member **58** (of header **52** and correspondingly to header **50**). The manifold **90** also has a plurality of upwardly pointing nozzles **93** which direct streams of the cleaning fluid **20** upwardly between the rotating spokes **42** of the ring **40** and onto the bottom or under portion of the workpiece. A U-bolt **91** secures the manifold **90** to the base plate **54**. Specifically, as illustrated in FIG. 5, the U-bolt **91** retains the manifold **90** within a recess **92** in the plate **54** with a manifold opening **94** positioned in alignment with a base plate opening **95** and the interior of the tubular member **58**. An annular sealing member **96**, such as an O-ring, is positioned around the opening **94** and between the base plate **54** and the manifold **90**. The manifold **90** is connected to the header **50** in a manner similar to that described hereinabove regarding the header **52**.

Although the use of two opposed headers in generally preferred, it should be understood that any suitable number of headers may be employed. If desired, several rows of nozzles ejecting fluid streams in one or more directions may be provided on each of the headers.

Referring particularly to FIGS. 1, 2, and 3, means is provided to rotate and oscillate the nozzles **68**, **70**, **72**, and **73** and the header **50** and the nozzles **80**, **82**, **84**, and **85** and the header **52** along predetermined arcuate paths for causing the cleaning fluid **20** to strike various portions of the workpiece and at varying angles of impingment in the same area. Such means includes a motor **97** driving an adjustable crank **97***a* secured to a centrally located motor shaft **98**, a pair of links **99** and **100** pivotally connected to the crank **97***a* and a pair of header-associated driving links **110** and **112** pivotally connected to the links **99** and **100**, respectively. The driving links **110** and **112** are rigidly connected to the respective headers **50** and **52**. It is apparent that rotation of the motor **94** will cause oscillation of the headers **50** and **52** through the above described linking means. Oscillation of the nozzles through an arcuate pattern provides comprehensive coverage of the rotating workpiece.

The rotating and oscillating means will cause the header **50** to rotate in a clockwise direction when the header **52** is rotating in a counterclockwise direction and will cause the header **50** to rotate in a counterclockwise direction when the header **52** is rotating in a clockwise direction. The nozzles in the headers **50** and **52** have a dead center position in which the fluid jets emitted from the nozzles are all in substantially the same plane, such plane also preferably including the longitudinal or central axes of the cleaning section **14** and the carriage **34**. As the motor **97** rotates the shaft **98**, the headers **50** and **52** rotate at the same rate from the dead center position. The purpose of rotating and oscillating the headers **50** and **52** together in this fashion is to reduce the force acting on the engine block tending to resist rotation thereof with the support member **38**. That is, if the nozzles were to oscillate so that they would exert a couple on the workpiece, then a motor **49** having a greater horsepower would be required to rotate the support member **38**.

For all-purpose work it has been found that rapidly oscillating the headers through approximately 12 to 15 cycles per minute while rotating the support member **38** and the workpiece about once every two minutes produces optimum results. The arc through which the headers **50** and **52** are oscillated is preferably about 60°. At the extremities of the cycle the jets of cleaning fluid are preferably tangential to the workpiece. Of course, the speed of the rotation of the support member **38**, the speed of oscillation of the headers **50** and **52**, and the length of the arc through which the headers oscillate can all be appropriately varied to suit particular cleaning requirements of the specific object being cleaned. Oscillation through a 60° cycle (30° on each side of the dead center position) has only a slight effect on force-balancing of the fluid streams.

An important feature of this invention is that the nozzles on the headers **50** and **52** preferably oscillate through a number of cycles which is not a whole number while the support member is rotated through one revolution. By operating in this manner, the jets of cleaning fluid strike different portions of the workpiece during each successive rotation of the support member **38**. By way of illustration, after about five to seven rotations of the support member **38** substantially every point on the surface of the workpiece will have been subjected to a direct or close blasting of the jets of the cleaning fluid **20**. Thus, an entire engine block may be cleaned without manual adjustment of the nozzles. In some instances an entire engine block may be thoroughly cleaned within two minutes. Still another advantage of the rapid oscillation of the nozzles and the slow rotation of the support member **38** is to insure that each of the jets of cleaning fluid will strike directly against the surface fluid from adjacent rather than impinging against spent fluid from an adjacent or opposed nozzle, thereby dissipating much of the energy of the jet prior to the time the jet strikes the workpiece.

As indicated earlier, one distinct advantage of the present invention resides in the efficient filtering and reusing of the cleaning fluid. Thus, as illustrated particularly in FIG. 2, the cleaning fluid **20** after impinging against the workpiece drains downwardly within the cleaning section **14** onto a downwardly sloping wall or base plate **116** and toward an opening **114**. The base plate **116** constitutes the upper zone of a sloping wall the lower zone of which comprises a filter or filter means **118**. The base plate **116** in turn directs the cleaning fluid onto the sloping filter **118**.

As the cleaning fluid **20** flows downwardly over the base plate **116** and onto the filter **118** it carries with it both relatively large particles of debris and relatively small particles of debris which have been removed from the workpiece. The larger particles are readily trapped on the upper surface of the slanted filter **118**, but the filtered cleaning fluid **20** containing the smaller particles is permitted to rapidly pass through the filter and into the reservoir **18**, from which the cleaning fluid is pumped back to the nozzles for reuse, as will be hereinafter described. The perforations in the filter **118** are generally about 0.015–0.030 openings. The filter **118** has a substantial self-cleaning action, since as the larger particles of debris accumulate on the upper surface of the filter they are flushed downwardly along the surface of the sloping filter into a basin or trap **120** located at the lowermost end of the filter **118**. A second filter **122** is also provided sloping upwardly away from the bottom of the trap **120**. The filter **122** serves to filter any of the cleaning fluid **20** which may pass into the trap **120**, as well as serving another important function, as will be hereinafter described. Because of its slope the filter **122** produces a self-cleaning action similar to the filter **118**, which is important in a rapidly recirculating system such as that provided herein.

Preferably, the filter **118** is not immersed in the cleaning fluid **20** contained in the reservoir **18**, and thus the filter does not tend to plug up. The base plate **116** extends over the entire width of the cleaning chamber **14** and the filter **118** covers the entire area above the cleaning fluid level between the end of the base plate **116** and the

trap **120** is a trough-shaped unit having a bottom **120***a* and upstanding side walls **121**. Similarly, the filter **122** covers the entire width of the reservoir **18** from the bottom of the trap **120** to the exterior wall of the reservoir **18**. Thus, the cleaning and loading sections **14** and **16**, respectively, are substantially separated from the interior of the tank **18** by the base plate **116**, the filter **118**, the trap **120**, and the filter **122**. The filters **118** and **122** are removable from the apparatus for replacement or, in the event it is required, manual cleaning thereof. It should also be noted that the filter **122** and the trap **120** may be connected so as to form an integral unit. Thus, when it is desired to remove the filter **122** and trap **120** from the reservoir **18** for cleaning, a hook from the hoist used to lift engine blocks onto the loading section **16** may be secured to a ring or handle **123** located on the trap **120** and the entire integral unit lifted from the reservoir.

After the cleaning fluid **20** containing the smaller particles of debris has passed through the filter **118** and in some instances through the filter **122** and into the reservoir **18**, it can be reused, and is preferably reused a substantial number of times. Referring particularly to FIG. 3, a conduit **124** extends into the reservoir **18** and is connected to the intake portion of a pump **126**. Upon operation of a motor **128** the cleaning fluid **20** is pumped upwardly from the reservoir **18** through a conduit **124**, into the intake portion of the pump **126**, through an inwardly directed pipe **129** and then through the fixed manifold **90** and thereafter to the headers **50** and **52** and the pipes **74** and **86**, and to and through the nozzles of the headers and the pipes **74**, **86**, and **90**, being directed at, and at least a portion of the cleaning fluid impinging, the workpiece. It has been found that it is advantageous to provide a generally straight pump intake rather than a curved intake.

The smaller particles in the recirculated cleaning fluid **20** when jetted against the workpiece are considerably abrasive and substantially enhance the cleaning action of the cleaning fluid. In addition, the smaller particles which are dispersed in the recirculated cleaning fluid reduce the foaming of the cleaning fluid. Uncontrolled foaming of the cleaning fluid can cause the reservoir **18** to overflow and can also cause the pump **126** to cavitate. The cleaning fluid **20**, it will be remembered, is usually a caustic solution, and when the caustic is mixed with oils and greases removed from a workpiece such as an engine block, soap and resulting foaming are produced.

It is preferred, therefore, that the smaller particles not be permitted to settle to the bottom of the reservoir **18** but that they be dispersed in the recirculated cleaning fluid **20**. Referring particularly to FIG. 3, this dispersion may be provided by a hydraulic agitator which includes a circular perforated pipe **130** lying along or near the bottom of the reservoir **18**. The pipe **130** is connected into the manifold **90** from which it is supplied a recirculated portion of the cleaning fluid **20**. The flow of recirculated cleaning fluid to the pipe **130** may be regulated by an automatic or manual valve (not shown) so that cleaning fluid is only directed to the pipe **130** as desired. The fluid discharged by the perforations in the pipe **130** hydraulically agitates the sludge and abrasive particles which tend to settle to the bottom of the reservoir **18** and disperses them throughout the cleaning fluid **20**. If desired, of course, other suitable agitation means may be provided such as mechanical agitation means and the like.

The cleaning action of the fluid **20** is improved as the temperature thereof is increased, preferably to a relatively hot temperature, which may be preselected, such as a temperature of about 160° F., and generally the temperature is within the range of about 160° F. to about 200° F. Heating means which may be provided is illustrated particularly by referring to FIG. 2. The heating means includes a burner or firebox **132** which supplies heat to and through a pipe or heat-exchange member **134**, which supplies heat to the cleaning fluid **20**. Preferably, the burner **132** is operated at a high temperature only when the pump **126** is in operation. As illustrated in this embodiment, a flue **136** is connected to the heat-exchange member **134** for escape of heat exchanged gases, including heat exchanged air.

The cleaning action of the fluid **20** also increases with the pressure of the fluid of the fluid ejected through the nozzles, and the pressure should, therefore, be high, for example, 500 p.s.i. and above.

Particularly, in high-volume operations, it may be desirable to utilize a multiple unit or apparatus which is capable of simultaneously cleaning a plurality of workpieces, such as a plurality of engine blocks. A single cleaning fluid reservoir and associated components corresponding to those earlier described can be used.

In addition, fixtures (not shown) of various designs may be provided to hold several workpieces such as crankshafts, oil pans, etc. for simultaneous cleaning. The design of the fixture will depend on the shape and size of the workpiece or workpieces. For example, one such fixture can be a wire basket. When such fixtures are used, they may be positioned or secured to the support member **38** in much the same manner as described above. If necessary, means for rigidly securing the fixture, or engine block or other workpiece, to the support member **38** may also be provided.

An important feature of this invention is that in addition to the earlier described function of the second obliquely extending filter **122**, the filter also permits simple and efficient cleaning of the trap **120** and reservoir **18** of accumulated and undesired debris. For example, the operator can open or remove the liquid or cover **22** and merely tilt the reservoir **18** toward the filter **122**, such as by attaching to the reservoir a hook used to hoist engine blocks and baskets. The spent cleaning fluid **20** is then permitted to drain through the filter **122**, and the debris in the reservoir **18** is filtered out of the spent cleaning fluid and remains in the reservoir. This debris is practically dry and can be readily removed and easily disposed of. Access to the debris in the reservoir is obtained by removing the filter **122** and the trap **120** and then reaching manually through an opening **123** into the reservoir. Then the debris is scooped up and removed from the reservoir and disposed of. Thereafter, fresh cleaning fluid may be introduced through the filter **122** or introduced into the reservoir through the opening **123** with the filter removed therefrom. The filter **122** may be provided with openings smaller than those provided in the filter **118** to further facilitate filtering of spent cleaning fluid.

The trap **120** may be cleaned of debris by removing or opening the lid **22** and the accumulated debris in the trap then easily removed therefrom and disposed of.

Other apparatus (not shown) for the present invention may also be provided, such as a cleaning fluid-level gauge carried by the reservoir **18**, means for automatically maintaining the level of the cleaning fluid **20** in the reservoir by automatically introducing additional (fresh) cleaning fluid or water therein, and means for automatically controlling and maintaining the temperature of the cleaning fluid. Other suitable apparatus known to those skilled in the art may also be provided.

Thus, the present invention provides compact apparatus for rapidly and efficiently cleaning workpieces such as engine blocks and the like, and permits the reuse of cleaning fluid on successive workpieces, with the distinct advantages of using the combination of filters described.

Various changes, modifications, and substitutions may be made in the present invention by one having ordinary skill in the art without necessarily departing from the spirit and scope of the invention.

We claim as our invention:

1. In a cleaning apparatus, the combination of:

(a) a supporting structure providing a cleaning-fluid

reservoir and a cleaning chamber above and communication with said reservoir;

(b) jet means in said cleaning chamber for spraying cleaning fluid from said reservoir on an object to be cleaned within said cleaning chamber;

(c) a sloping wall carried by said supporting structure and positioned directly beneath said cleaning chamber to receive cleaning fluid sprayed against the object and debris removed from the object by the cleaning fluid;

(d) said sloping wall having a lowermost zone comprising first filter means for removing larger particles of debris from the cleaning fluid falling onto said sloping wall and for passing a major portion of the cleaning fluid falling onto said sloping wall, and smaller particles of debris, to said reservoir;

(e) said first filter means having a lower edge over which at least some of the cleaning fluid falling on said sloping wall, and larger particles of debris, are discharged;

(f) a trap below and communicating with said lower edge of said first filter means for collecting the larger particles of debris discharged over said lower edge; and

(g) said trap being provided with a second filter means for returning to said reservoir the cleaning fluid discharged over said lower edge of said first filter means, said second filter means is located on the side of said trap opposite said lower edge of said first filter means and slops upwardly from the bottom of said trap.

2. A cleaning apparatus as defined in claim 1 wherein at least said first filter means is positioned above the level of cleaning fluid in said reservoir.

3. A cleaning apparatus according to claim 2 wherein said sloping wall is imperforate above said lowermost zone thereof to cause the cleaning fluid falling on said sloping wall to flood the upper surface of said first filter means.

4. A cleaning apparatus as set forth in claim 1 including:

(a) an opening in said supporting structure and communicating with said reservoir through which opening fresh cleaning fluid may be added and spent cleaning fluid and accumulated debris withdrawn; and

(b) means removably secured to said supporting structure for closing said opening.

5. A cleaning apparatus as set forth in claim 1 wherein said first and second filter means are removably mounted on said supporting structure.

References Cited

UNITED STATES PATENTS

2,894,631	7/1959	Levit et al.	134—111 XR
2,949,120	8/1960	Federighi et al.	134—111 XR
1,605,961	11/1926	Loew	134—111
2,229,663	1/1941	Meeker et al.	
3,070,104	12/1962	Faust et al.	134—165 XR

FOREIGN PATENTS

607,778	9/1948	Great Britain.

ROBERT L. BLEUTGE, *Primary Examiner.*

U.S. Cl. X.R.

134—111, 165

U.S. DEPARTMENT OF COMMERCE

PATENT OFFICE

Washington, D.C. 20231

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,439,689 April 22, 1969

Emil Zadron et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 47, "ths" should read -- this --. Column 7, line 29, "in" should read -- is --. Column 8, line 30, "fluid from adjacent" should read -- of the workpiece --. Column 9, line 1, after "120" insert -- . The trap 120 --; line 28, "inwardly" should read -- upwardly --. Column 10, line 33, "liquid" should read -- lid --. Column 11, line 30, "slops" should read -- slopes --.

Signed and sealed this 14th day of April 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents