Jan. 15, 1963 G. W. BALZ 3,074,068

CLEANING AND TREATING MACHINE

Filed Oct. 3, 1961

3 Sheets-Sheet 1

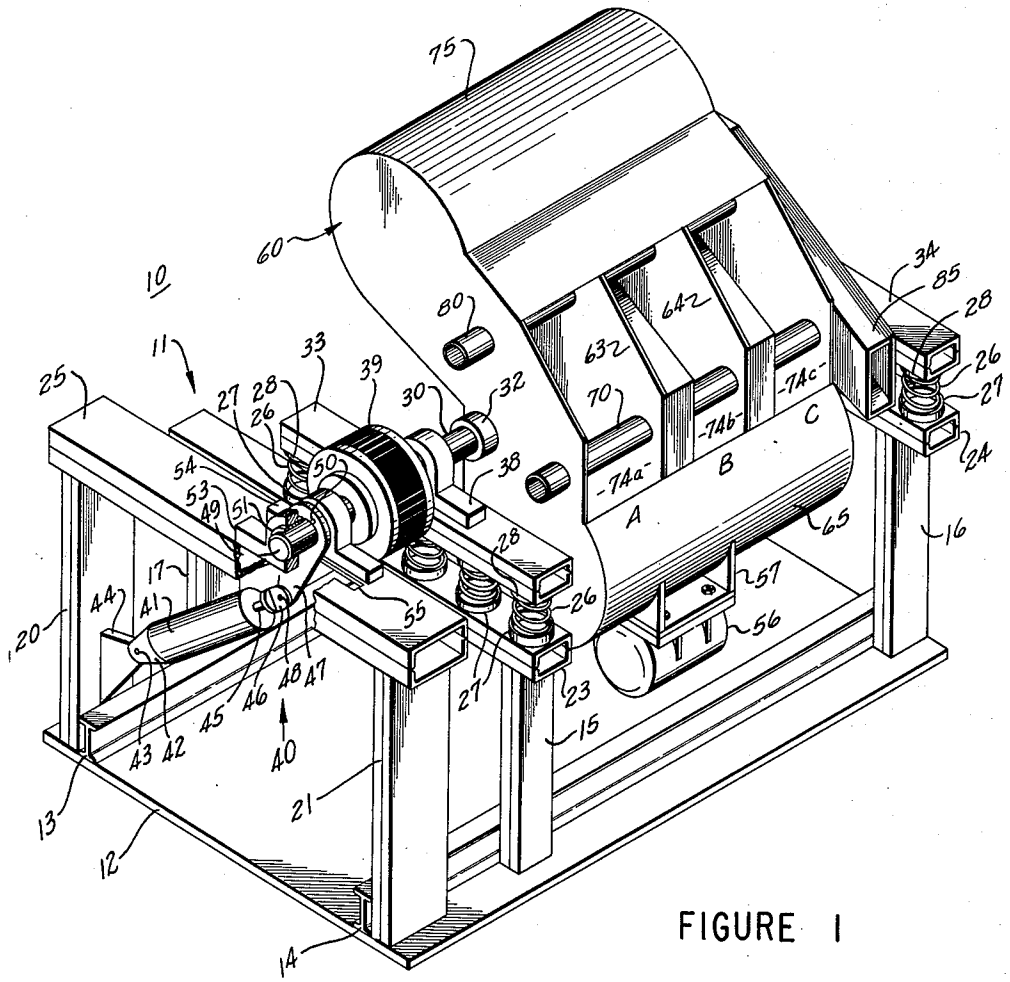


FIGURE 1

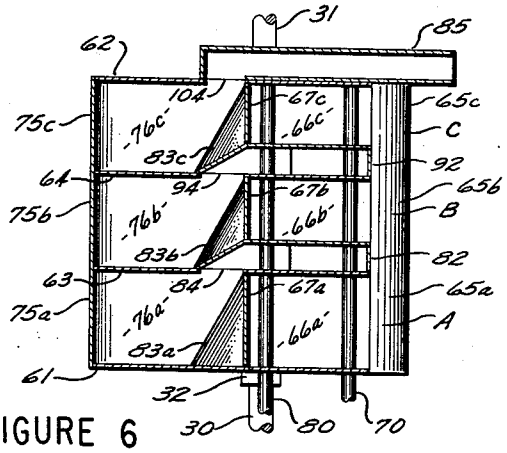


FIGURE 6

INVENTOR.
GUNTHER W. BALZ
BY Gudrun V. Kueschen
ATTORNEY

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3 Sheets-Sheet 2

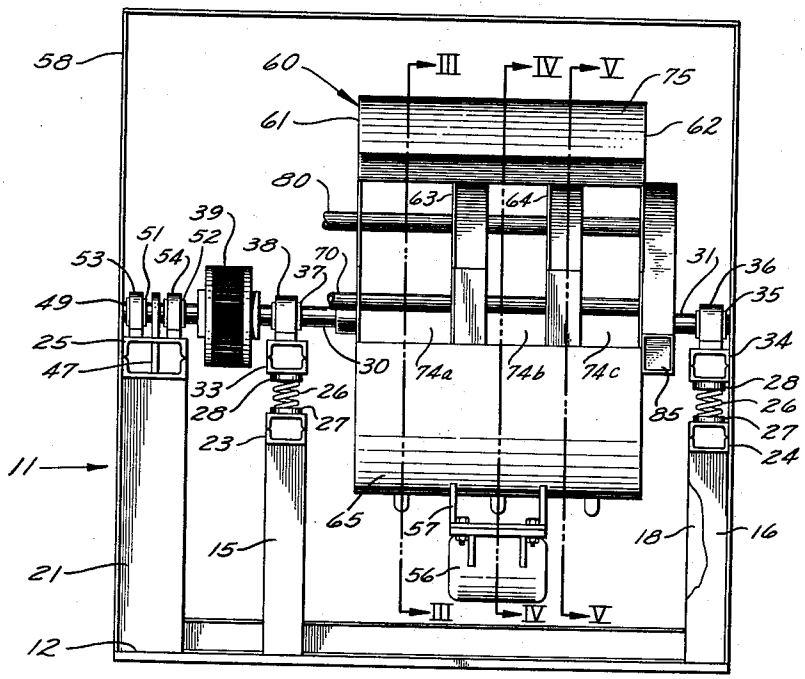


FIGURE 2

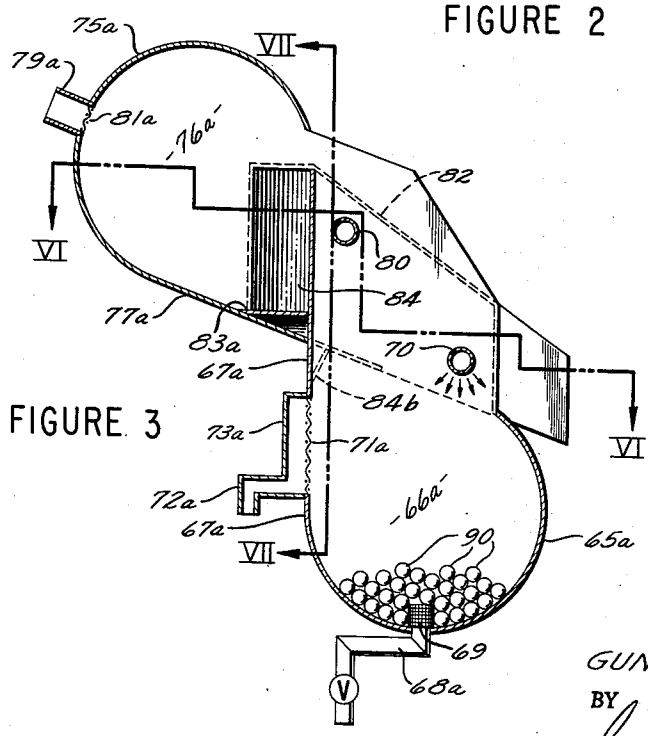


FIGURE 3

INVENTOR.
GUNTHER W. BALZ
BY
ATTORNEY

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CLEANING AND TREATING MACHINE

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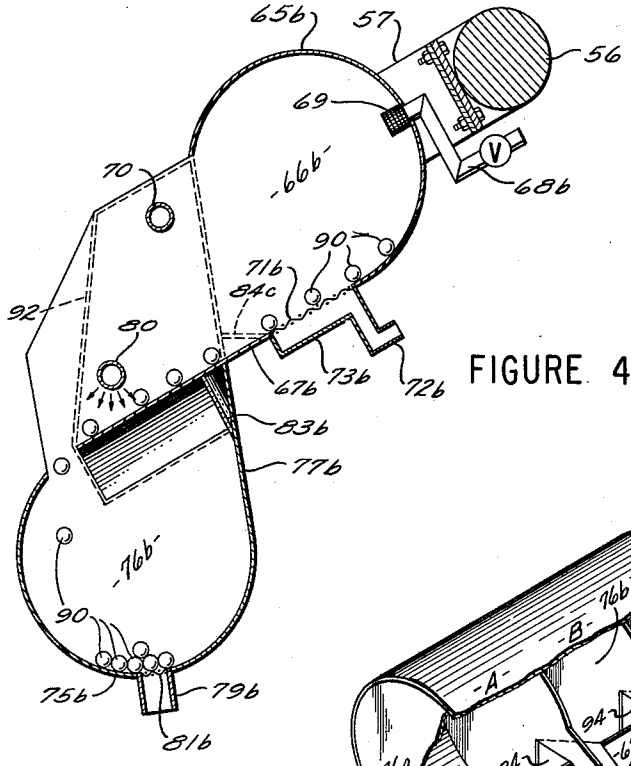


FIGURE 4

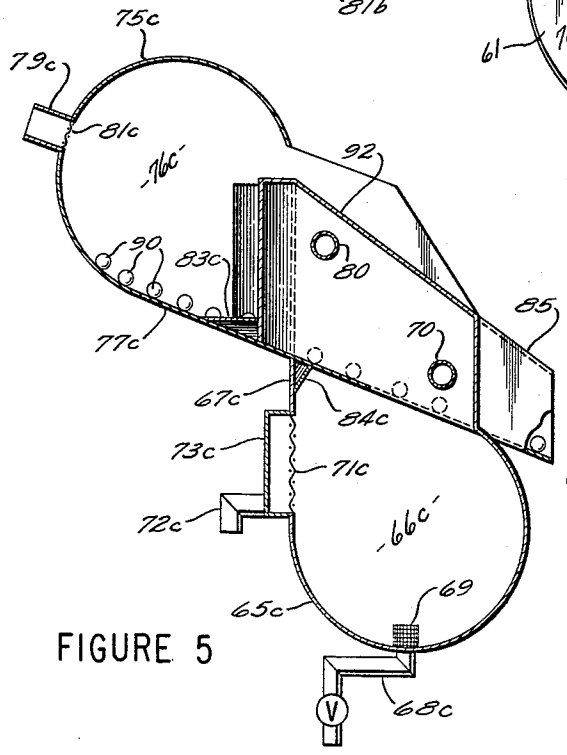


FIGURE 5

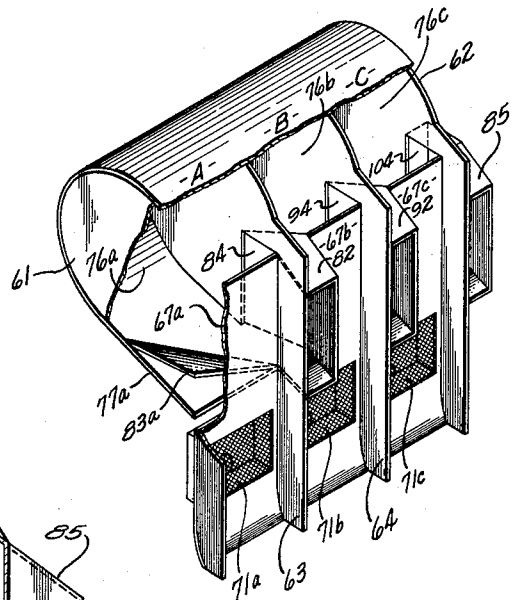


FIGURE 7

INVENTOR.
GUNTHER W. BALZ
BY Edward Kuescher
ATTORNEY

United States Patent Office 3,074,068 Patented Jan. 15, 1963

3,074,068

CLEANING AND TREATING MACHINE

Gunther W. Balz, Kalamazoo, Mich., assignor to Ransohoff Company, Hamilton, Ohio, a corporation of Ohio

Filed Oct. 3, 1961, Ser. No. 142,598
12 Claims. (Cl. 134—69)

The present invention relates to a cleaning and treating machine, and is more particularly concerned with such machine wherein parts may be cleaned and/or treated in the presence of controlled alternating waves of energy and conventiently transferred from one compartment to another by rotation of a housing, and preferably from one cleaning or treating stage to another by rotation of a multi-stage housing.

Cleaning machines or washing machine, as they are commonly termed, whereby uncleaned parts are vibrated in a cleaning fluid, have been developed to a high state of perfection. In such prior art cleaning machines, the parts are usually deposited in a perforated basket which is vibrated after being lowered into a tank containing cleaning fluid for removing grease, corrosion, and the like therefrom. When they must be subjected to more than one cleaning fluid, the parts are ordinarily removed from the basket, rinsed thoroughly to remove residual fluid, and deposited in another perforated basket which in turn is vibrated after being lowered into a second tank containing a different type of cleaning fluid. Such operation must be repeated each time it is desired to clean the parts with additional fluid or coat them with a chemical solution, or subject them to like treatment. Other types of cleaning and treating machines, although they may contain a plurality of chambers, have no efficient means for agitation of the parts.

When cleaning or treating parts in series with several different types of fluids, it is preferable that the overall operation be substantially automatic and efficient so as to reduce the amount of labor involved. One such satisfactory cleaning machine, in which parts are moved by vibratory conveyors, is disclosed and claimed in my copending application, Serial No. 88,811, filed February 13, 1961. It is also desirable to make the machine as compact as possible so that a minimum of floor space is utilized. The present invention is primarily concerned with a multi-stage cleaning and treating machine in which the parts are inserted into a cleaning compartment thereof, vibrated and cleaned or treated with a fluid, automatically transferred by rotative means to a rinsing compartment, and then to succeeding sections containing cleaning and rinsing compartments before they are discharged from the last section of the machine.

Broadly speaking, vibratory cleaning and treating of parts encompasses any method in which alternating waves of energy are employed to increase turbulence and mechanical action around the part being processed. For example, by means of a multi-stage cleaning and treating machine according to the invention, it is possible to vibrate a mass of uncleaned parts with heavy, medium or light duty alkaline cleaning fluids for removing soils such as oils or greases from ferrous, non-ferrous or other metal parts, then automatically transfer the parts to a rinsing compartment in the same or succeeding stage which contains rinsing fluid for removing residual cleaning fluid from the parts, then automatically transfer the parts to a succeeding cleaning compartment containing an acidic compound for removing tarnish, scale and/or rust, then automatically transfer the parts to another rinsing compartment for removing residual cleaning compound, and then automatically transfer the parts to succeeding compartments containing coating compounds such as phosphates and the like for purposes of conditioning metal and for depositing on the metal surface a coating, whereafter the parts may be discharged from the machine. Various types of pickling compounds, solvents, emulsions, rust preventive compounds, bright dip solutions and the like may be employed in the machine. This is in contrast to past practice, in which uncleaned or soiled parts were transferred manually or by conveyors from one machine to another.

Accordingly, it is an object of the present invention to provide an improved cleaning and treating machine having one or more stages.

An additional object of the present invention resides in the provision of a parts cleaning and treating machine whereby parts inserted into a cleaning compartment may be automatically transferred by rotative means to a rinsing compartment and then transferred out of the machine.

It is another object of the present invention to provide a multi-stage cleaning and treating machine for automatically transferring parts from one cleaning and rinsing section to a succeeding cleaning and rinsing section.

Another object of the present invention is to provide a multi-stage cleaning and treating machine whereby the parts are transferred from one cleaning compartment to its respective rinsing compartment by rotating the compartments as a unit.

A further object of the present invention is to provide a multi-stage cleaning and treating machine whereby the parts are transferred from one cleaning and rinsing section to a succeeding cleaning and rinsing section or out of the machine by rotating the sections as a unit, which device is positively self-clearing and non-clogging.

A still further object of the present invention is to provide a multi-stage cleaning and treating machine employing vibration generating means for imparting orbital vibrations to each of the cleaning and rinsing sections and to the parts therein while they are being cleaned or rinsed.

It is a further object of the present invention to provide a multi-stage cleaning and treating machine comprising a simple and compact unit.

Still another object of the present invention resides in a multi-stage cleaning and treating machine whereby the parts are deposited into the first section, cleaned or treated with the aid of vibrations, and discharged from the last section on the same side of the machine.

Additional objects and advantages of the present invention will be apparent to one skilled in the art and still other advantages will become apparent hereinafter.

To the accomplishment of the foregoing and related ends, the present invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description setting forth in detail a certain illustrative embodiment of the invention, being indicative, however, of but one of the ways in which the principles of the invention may be employed.

For a better understanding of the present invention, reference may be had to the accompanying drawings in which:

FIGURE 1 is an isometric view of a multi-stage cleaning and treating machine embodying the present invention;

FIGURE 2 is a front elevational view of the machine shown in FIGURE 1 inside of a sound insulating box with the front portion removed;

FIGURE 3 is a vertical section taken on line III—III of FIGURE 2 showing the internal construction of the first stage of the multi-stage housing in a loading or cleaning position with uncleaned parts in the cleaning compartment;

FIGURE 4 is a vertical section taken on line IV—IV

of FIGURE 2 to show the details of the internal construction of the second stage of the multi-stage housing rotated to a transfer position with cleaned parts leaving the cleaning compartment;

FIGURE 5 is a vertical section taken on line V—V of FIGURE 2 to show the details of the internal construction of the third stage of the multi-stage housing rotated to the cleaning or discharge position with rinsed parts leaving the machine;

FIGURE 6 is a section taken on line VI—VI of FIGURE 3 with portions cut away better to illustrate certain constructional details of the housing, assuming that FIGURE 3 shows the complete structure thereof; and

FIGURE 7 is an isometric section taken on line VII—VII of FIGURE 3 with portions cut away better to illustrate certain constructional details of the transfer chutes of the housing, assuming that FIGURE 3 shows the complete structure.

In general, the improved multi-stage cleaning and treating machine described herein comprises a plurality of sections, each of which is provided with an opening through which uncleaned parts may be deposited into any of the cleaning compartments thereof. One or more conduits having fluid-directing apertures are so mounted with respect to each cleaning compartment as to provide a source for supplying fluid to the uncleaned parts therein. When the cleaning cycle is completed, the plurality of sections is rotated to a transfer position and the parts are directed into a rinsing compartment of the same section. One or more conduits having fluid-directing apertures are properly mounted with respect to each rinsing compartment for supplying a rinse fluid spray for removing residual solution or fluid from the parts. After the rinsing cycle is completed, the sections are rotated to their original position and the rinsed parts in each rinsing compartment are transferred into a cleaning compartment in a succeeding section where another type of fluid is directed upon the parts. At the same time the rinsed parts in the rinsing compartment of the last section are directed into a discharge chute and discharged from the machine. Additional uncleaned parts may at such time be inserted into the first cleaning compartment.

A vibratory motor is provided for imparting orbital vibrations to the sections in various positions of rotation, and is preferably mounted to one or more sections or to a housing for all of the sections. Each of the compartments in each section may be provided with a drain for removing the fluid therefrom. The fluid drained from each of the cleaning compartments flows into a tank and, after suitable filtering, the fluid is pumped back to the same conduit in each of the cleaning compartments under pressure. The rinse fluid from each of the rinsing compartments normally drains into a sewer.

Reference is now made to the accompanying drawings for a better understanding of the invention, in which all the parts are numbered and in which the same numbers are used to refer to corresponding parts throughout.

Referring now particularly to FIGURE 1 of the drawings, there is illustrated a multi-stage cleaning and treating machine, generally indicated at **10**, which comprises a frame **11**. Journaled on the frame for rotation about a horizontal axis are a plurality of sections or a multi-stage housing **60**. For the purpose of rotating the housing from one position to another, there is included a rotary mechanism, generally designated at **40**, which is carried by the frame **11**.

Considering first the frame **11**, and specifically the stationary portion of the frame, it comprises a base plate **12** having a pair of I-beams or rails **13** and **14** welded thereto in spaced parallel relationship. Vertical frame members or standards **15**, **16**, **17** and **18** are welded at their respective end portions to the base plate **12** and rails **13** and **14**. More specifically, the lower end portions of standards **15** and **16** are welded to rail **14** and standards **17** and **18** are welded to rail **13**. Two additional vertical frame members or standards **20** and **21** are welded at their lower end portions respectively to rails **13** and **14** and to the base plate **12**.

For the purpose of supporting the housing on the frame, lower cross members **23** and **24** are welded to the upper ends of vertical frame members **15** and **17**, and **16** and **18** respectively. Moreover, in order to support the rotary mechanism **40**, cross member **25** is welded to the top portions of vertical frame members **20** and **21**. Each of the vertical frame members and cross members comprise a pair of channel iron beams welded together. The securing together of the base plate **12**, the rails **13** and **14**, vertical frame members **15**, **16**, **17**, **18**, **20** and **21**, and the cross members **23**, **24** and **25** by welding or other suitable means completes the stationary portion of the frame **11**.

As clearly shown in FIGURES 1 and 2 of the drawings, a plurality of coiled helical springs **26** are employed for isolating the orbital vibrations of the housing **60** from the frame **11**. A plurality of suitable cup-shaped members **27** are secured and equally spaced along the top side of each of the lower cross members **23** and **24**. Similar cup-shaped members **28** are inverted and secured to the bottom side of each of upper cross members **33** and **34** and aligned with cup-shaped members **27** for supporting the coiled helical springs **26**. It should be understood that it is not necessary to employ coiled helical springs for isolating the vibrations of the housing from the frame **11** as various other types of resilient members can be employed. In the illustrated arrangement, the housing **60** being resiliently supported by a plurality of coiled helical springs is thereby supported for substantial free movement in space.

Since, as will become apparent from the following description, the housing **60** is journaled for rotation on a horizontal axis, the housing can be rotated from a loading, cleaning or discharge position to a transfer or rinsing position and then to the original loading position. Preferably, and as illustrated in FIGURES 1 and 2 of the drawings, the housing is provided with a shaft or a pair of spindles **30** and **31** having their end portions respectively secured to the side plates **61** and **62** of the housing **60** by means of cylindrical members **32**. Spindle **31** is journaled in a bearing **35** which is inserted in a bearing support member **36** mounted on the top portion of upper cross member **34**. Likewise, spindle **30** is journaled in bearing **37** which is inserted in bearing support member **38** mounted on the top portion of upper cross member **33**. The other end portion of spindle **30** is mounted to a flexible coupling **39** in order to isolate the vibrations of the housing from the rotary mechanism **40**.

Considering now the rotary mechanism, generally designated at **40** in FIGURE 1 of the drawings, it comprises suitable means for rotating the housing **60** such as a pneumatic or hydraulic cylinder **41**. The connections to the cylinder **41** are not shown since they are conventional. The lower end of cylinder **41** is provided with a lug **42** pivotally secured by a pin **43** to a side plate **44** which is rigidly secured to the inside of vertical frame member **20**. The other end of the cylinder is provided with a piston rod **45** having its outer end secured to a lug **46** which is pivotally secured to one end of crank arm **47** by a pin **48**. The other end of the crank arm is rigidly secured to a shaft **49** by means of a key **50**. The shaft **49** is journaled in a pair of bearings **51** and **52** each of which is respectively inserted into bearing support members **53** and **54** mounted in spaced parallel relationship on the top of cross member **25**. A slot **55** is provided in the cross member **25** intermediate the bearing support members **53** and **54** and the crank arm **47** disposed in the slot **55** can freely rotate through an angle therein. One end of the shaft **49** is connected to the flexible coupling **39**. By energizing the cylinder **41**, the piston rod **45** is forced outwardly and

rotates crank arm 47 which rotates shaft 49, coupling 39 and spindle 30, thereby rotating the housing from the cleaning or loading position to the rinsing position. When it is desired to rotate the housing back to its original position, the cylinder is energized in reverse.

The cylinder 41 for rotating the housing 60 can be energized by a pre-set automatic control panel which is not shown since it is conventional, or the cylinder can be energized manually after pre-determined periods have elapsed.

As shown in FIGURE 2, the unitary multi-stage cleaning machine 10 including the frame 11 and the housing 60 is enclosed in a sound insulating box 58 having suitable openings for loading and unloading the machine.

A vibration generating means, such as a vibratory motor 56 is shown fixedly secured to the housing 60 by means of a motor mounting bracket 57 and suitable bolts and nuts. The connections to the vibration generating means 56 are not shown since they are conventional. The motor can comprise any power means including an electric as well as a fluid motor. For example, the motor can be of the rotating type, the vibratory type, the hydraulic or pneumatic type, or a prime mover. Depending upon the number of sections or units and somewhat on the degree of rigidity with which they are secured together, one motor can be employed for imparting orbital vibrations to the unitary housing or a plurality of motors can be mounted to the housing, such as one motor for each section or every two sections. If a plurality of motors is mounted to the housing and the sections are rigidly secured to each other, then the rotor shafts can be coupled together to synchronize the orbital vibrations of the motors.

Greatest efficiency of the orbital vibrations is achieved by disposing the vibratory means 56 with respect to the housing so that the orbital vibrations move the mass of parts in the housing transversely or normal to the longitudinal axis of each of the compartments. It will be understood, however, that satisfactory vibrations can also be imparted to the housing so long as a component of each orbital vibration lies in a transverse plane of the housing. It is, however, not essential that the vibratory means be secured to one or more sections or a housing therefor, so long as it is operative to impart vibratory motion thereto in at least one position of rotation.

By imparting vibrations to the housing, the mass of parts therein receives controlled vibrations and moves in an orbital manner. These vibrations substantially increase the efficiency of the cleaning or treating operation since the alternating waves of energy developed by the vibrations increase the turbulence around the parts being processed. During the transfer of parts from one compartment to another the controlled vibrations also dislodge any parts which may adhere to the walls.

As shown in FIGURES 1, 2, 6 and 7 of the drawings, the housing 60 is provided with three sections which will hereinafter be referred to as sections A, B and C. Although the cleaning machine housing 60 is provided with partitions 63 and 64 for dividing it into sections A, B and C, it will be understood that each section can be made as a separate unit. The units can then be secured together to provide a multistage housing.

Preferably and as illustrated, the housing 60 is provided with a rounded bottom 65 of semi-cylindrical form defining the bottom of cleaning compartments 66*a*, 66*b* and 66*c* and rounded top 75 of semi-cylindrical form defining the top of rinsing compartments 76*a*, 76*b* and 76*c*. The sides of rounded bottom 65 and rounded top 75 extend toward side plates 61 and 62 and are suitably welded thereto. The cleaning compartment in each section of the housing is preferably at least partially opposed to the respective rinsing compartment, that is, in the preferred form of the invention the longitudinal planes bisecting the compartments of one section into substantially equal portions form an angle greater than ninety degrees. Sections A, B and C are provided with openings 74*a*, 74*b* and 74*c* respectively for inserting uncleaned parts into the cleaning compartments 66*a*, 66*b* and 66*c* respectively.

From the above description and particularly from FIGURE 6 of the drawings, it is apparent that each section A, B and C is provided with two compartments. Section A is provided with cleaning compartment 66*a* defined by rounded bottom 65*a*, lower rear wall 67*a* which is an extension of one end of rounded bottom 65*a* (see FIGURE 3), a portion of side plate 61 and a portion of partition 63, and rinsing compartment 76*a* defined by rounded top 75*a*, upper rear wall 77*a* (see FIGURE 3) which is an extension of one end of the rounded top 75*a*, a portion of side plate 61 and a portion of partition 63. Section B is provided with cleaning compartment 66*b* defined by rounded bottom 65*b*, lower rear wall 67*b* which is an extension of one end of the rounded bottom 65*b*, and portions of partitions 63 and 64, and rinsing compartment 76*b* defined by rounded top 75*b*, upper rear wall 77*b* which is an extension of one end of rounded top 75*b*, and portions of partitions 63 and 64. Section C is likewise provided with cleaning compartment 66*c* defined by rounded bottom 65*c*, lower rear wall 67*c* and portions of partition 64 and side plate 62, and rinsing compartment 76*c* defined by rounded top 75*c*, upper rear wall 77*c* and portions of partition 64 and side plate 62.

As best illustrated in FIGURE 7, the lower rear walls 67*a*, 67*b* and 67*c* extend partially into rising compartments 76*a*, 76*b* and 76*c* respectively and the ends of the upper rear walls 77*a*, 77*b* and 77*c* butt up against the respective bottom sides of the lower rear walls (see FIGURES 3, 4 and 5). In the preferred form of the invention, the exterior angle formed by each of the lower and respective upper rear walls is an obtuse angle. Satisfactory transfer of the parts can, however, be obtained even if the exterior angle is somewhat less than ninety degrees.

A conduit 70 provided with fluid-directing apertures along one side thereof and extending substantially normal to the longitudinal axis thereof is disposed longitudinally in the housing, as best seen in FIGURES 1, 2 and 6 of the drawings, for supplying fluid pumped from a not shown storage tank to the parts in the cleaning compartments. In the illustrated arrangement, only one conduit 70 or fluid-injecting means is employed for supplying the cleaning compartments with fluid. It is to be understood, however, that a separate conduit or fluid-injecting means can be employed for supplying fluid to each of the cleaning compartments and each fluid-injecting means can supply a different type of solution and be connected to a separate storage tank. Whether one or more storage tanks are employed, each tank is provided with a conventional (not shown) filter and fluid pump so as always to supply clean fluid to the cleaning compartments by means of the conduit 70.

For the purpose of draining the fluid or solution from each of the cleaning compartments 66*a*, 66*b* and 66*c*, drain conduits 68*a*, 68*b* and 68*c* are inserted into openings provided in each of the rounded bottoms 65*a*, 65*b* and 65*c* (see FIGURES 3, 4 and 5). In order to prevent the parts in the washing compartments from flowing down the drains, foraminous members 69 are detachably secured over the inner openings of the drain conduits. Conventional valves are connected to each of the drain conduits for controlling the discharge of fluid or solution to one or more not shown storage tanks. After the cleaning cycle is completed, and the supply of cleaning fluid discontinued, valves in each of the drain conduits 68*a*, 68*b* and 68*c* are opened, and the solutions in each of the washing compartments 66*a*, 66*b* and 66*c* are drained therefrom. Depending upon the type of cleaning operation, it is sometimes preferred to leave the valves open in drains 68*a*, 68*b* and 68*c* and continuously drain the fluid directed upon the parts in the cleaning compartments.

Due to the intricate configuration of some of the parts which are cleaned, it is possible that some of the solution can be trapped in crevices or cavities thereof. For the

purpose of removing the fluid or solution trapped in the cavities of the parts before they are transferred to the rinsing compartment, an additional drain is inserted into an opening in each of the lower rear walls. More specifically, foraminous members **71***a*, **71***b* and **71***c* are provided in openings in the lower rear walls **67***a*, **67***b* and **67***c* respectively. Drain chambers **73***a*, **73***b* and **73***c* are mounted to the outside rear walls over the openings therein containing the foraminous members. Drain conduits **72***a*, **72***b* and **72***c* are connected to each of the drain chambers **73***a*, **73***b* and **73***c* respectively. Each of the drain conduits **72***a*, **72***b* and **72***c* discharges the solution into the appropriate storage tank. From the above description and particularly from FIGURE 4 of the drawings, it will be apparent that as the housing is rotated to the transfer position any fluid trapped in the parts themselves will be separated therefrom and flow into the drains provided in the lower rear walls as the parts flow down the rear wall of each of the cleaning compartments with the assistance of the vibratory motions imparted by the motor **56** to the housing **60**.

If the valves in drain conduits **68***a*, **68***b* and **68***c* are closed during the cleaning operation, excess fluid is discharged from the cleaning compartment through drain conduits **72***a*, **72***b* and **72***c* respectively.

Preferably and as illustrated, another tube or conduit **80** disposed longitudinally in the housing is provided with a plurality of fluid-directing apertures along one side thereof and extending substantially normal to the longitudinal axis thereof for supplying tap water or other rinsing fluid under pressure to the cleaned parts as they flow down from the cleaning compartment wall into their respective rinsing compartment to remove quickly any of the solution from the washed parts.

In the preferred form of the invention the conduit **80** is disposed in juxtaposition to the distal ends of the lower rear walls **67***a*, **67***b* and **67***c* so as to direct the rinsing fluid or tap water on the parts as they are being transferred into the respective rinsing compartments. It is to be understood, however, that the conduit **80** can be disposed on the other side of the rear walls **67***a*, **67***b* and **67***c* for directing tap water or pumped fluid to the parts after they are deposited in the rinsing compartments, or else the distal ends of the lower rear walls can be shortened so as to permit direct discharge of rinsing fluid into the rinsing compartments. A separate conduit or fluid-injecting means can be provided for each rinsing compartment whenever it is necessary to rinse the parts with different types of fluid. In the preferred form of the invention, I employ conduits **70** and **80** having fluid-directing apertures in the housing for directing fluid upon the parts **90**. It is to be understood that spray nozzles or other conventional fluid-directing means may be employed instead of the conduits.

Suitable drain conduits **79***a*, **79***b* and **79***c* with not shown valves are inserted in openings in each of the rounded tops in rinsing compartments **76***a*, **76***b* and **76***c* respectively for draining the tap water from the rinsing compartments. Each of the drains **79***a*, **79***b* and **79***c* in the rinsing compartments is provided with screens **81***a*, **81***b* and **81***c* respectively to prevent parts from being discharged therethrough. The drains are normally connected to sewers. If the conduit **80**, however, supplies a rinsing fluid or solution, similar not shown conventional storage tanks, filters and fluid pumps can be employed as with the conduits **70** of the cleaning compartments.

It will be appreciated that when the housing is rotated from the rinsing position to the cleaning or loading position, it is necessary that the parts be transferred from one section of the housing to a succeeding section thereof and not returned to the same cleaning compartment. To this end, as best shown in FIGURES 6 and 7 of the drawings, transfer duct **82** is disposed in section B of the housing **60** and communicates with rinsing compartment **76***a* by means of an opening **84** provided in partition **63**. The end portion of the lower rear wall **67***a* acts as a baffle and prevents the rinsed parts from flowing back into cleaning compartment **66***a*. Likewise, lower rear walls **67***b* and **67***c* also act as baffles and prevent the parts from flowing from the rinsing compartments to the respective cleaning compartments.

A riser **83***a* is provided in section A of the housing and more specifically the riser **83***a* is disposed in a space defined by lower rear wall **67***a*, upper rear wall **77***a* and a portion of side plate **61**. The riser **83***a* directs the parts from the rinsing compartment **76***a* into opening **84**, through duct **82** and into cleaning compartment **66***b* when the housing is rotated from the rinsing position to the cleaning or loading position.

Likewise, transfer duct **92** is disposed in section C of the housing **60** and communicates with rinsing compartment **76***b* of section B of the housing by means of an opening **94** provided in partition **64** for transferring parts from rinsing compartment **76***b* to cleaning compartment **66***c*. A riser **83***b* is also disposed in section B of the housing similar to riser **83***a* for directing the parts from rinsing compartment **76**b into opening **94**, through duct **92** and into cleaning compartment **66***c* when the housing is rotated from the rinsing position to the cleaning or loading position. Riser **83***c* is also similarly disposed in section C of the housing. Ducts **82** and **92** respectively may be mounted on either side of partitions **63** and **64** and the upper rear walls of each rinsing compartment may be suitably angled, in which case the risers become unnecessary.

As best seen in FIGURES 3, 4 and 5, suitable risers **84***b* and **84***c* are also disposed below ducts **82** and **92** in the cleaning compartmenst **66***b* and **66***c* respectively in order to prevent any parts from being lodged against the outside bottom walls of ducts **82** and **92** when the housing is rotated from the cleaning to the rinsing position. Alternatively, the bottom wall of each duct may be suitably angled to prevent entrapment of parts, in which case the risers **84***b* and **84***c* become unnecessary.

A discharge chute **85** (see FIGURES 6 and 7) communicates with an opening **104** provided in side plate **62** which is the outside wall of the last section of the housing in the illustrated arrangement and referred to as section C thereof. The parts are discharged from the rinsing compartment **76***c*, into the chute **85** which may also be a duct similar to ducts **82** and **92**, and out of the machine when the housing is rotated from the rinsing position to the loading or cleaning position.

From the foregoing description and particularly from FIGURE 1 of the drawings, it will be apparent that the discharge chute **85** and the openings **74***a*, **74***b* and **74***c* of the cleaning compartments in sections A, B and C respectively are along the same side of the machine.

Furthermore, by rapidly transferring the parts from one cleaning compartment to its respective rinsing compartment, the parts are not exposed to the atmosphere for any significant period and therefore are not subject to corrosion, surface deterioration, or the like.

In operation, uncleaned parts are inserted into an opening in the first or in a succeeding compartment of the series of cleaning compartments. In a particular case, if any advantage is served thereby, parts may also be first inserted into the rinsing compartment. When only one cleaning operation is necessary, uncleaned parts are inserted into the cleaning compartment of the last section of the series. The opening or openings through which parts are introduced may optionally be closed during subsequent operations. The machine can, therefore, be operated as a single-stage cleaning machine. The vibratory motor is energized for imparting alternating waves of energy to the housing and to the contents therein for increasing the turbulence around the parts and for continuously moving the parts as a mass in an orbital motion transversely in each compartment. At the same time the cleaning fluid pump is energized for

supplying fluid in the conduit having fluid-directing apertures along one side thereof. The fluid is directed on the parts as they move in an orbital motion in the cleaning compartment. The fluid can be continuously drained from the cleaning compartments by drains or permitted to remain therein until the end of the cleaning cycle at which time it can be discharged therefrom through a drain and returned to the storage tank.

After a predetermined period has elapsed, the supply of cleaning fluid has been discontinued, and all the fluid has been drained from the cleaning compartments, the housing is rotated to the rinsing position and the parts gravitate with the assistance of the vibrations down the lower rear walls of the cleaning compartments. As the parts move toward or enter the rinsing compartment, depending on the location of the rinse fluid-directing means, the rinse fluid spray is activated and the parts are sprayed with rinse fluid for removing the cleaning or washing fluid therefrom. Drains are provided in the rinsing compartments for removing any of the rinse fluid which collects therein. When all of the parts are sprayed or rinsed and deposited in the rinsing compartment, the housing is rotated back to its loading or cleaning position. The rinsed parts gravitate down the upper rear wall of the rinsing compartment with the aid of the vibrations and are directed by the riser through an opening and into the transfer duct which directs the parts into the succeeding cleaning compartment. At the same time an additional charge of unwashed parts is inserted into the first cleaning compartment of the series. After the first cleaning compartment has been charged with uncleaned parts and all of the parts have been transferred from the rinsing compartment of the first section into the washing compartment of the second section, the cleaning cycle is repeated. At the end of the second cleaning cycle, the housing is again rotated to the rinsing position and the parts in each of the cleaning compartments gravitate with the assistance of the vibrations down the lower rear walls and are directed into the respective rinsing compartments. When the parts are completely rinsed either in the rinsing compartment of the last section or series of housings, or just prior to entering same, they are ready to be discharged from the housing as soon as the housing is rotated back to the loading or cleaning position.

For certain operating conditions, it may be preferable to modify slightly the rotary mechanism, the relative positions of components within the housing, and the connections to the motor for rotating the housing through one or more cycles in the same direction, that is, so that the housing can be rotated through a complete revolution when it is rotated from the cleaning position to the rinsing position and then back to the cleaning position.

The housing can contain as many sections as there are different types of cleaning solutions. Moreover, the cleaning fluid in each cleaning compartment can be of the same type while the rinsing fluid for each rinsing compartment is of a different type, or vice versa. Some of the conduits may contain hot gases for drying the parts. Depending on the type of fluid or solution employed, the fluid from each compartment can be drained into a separate storage tank, filtered and then pumped back under pressure to the same compartment for reuse. Whenever tap water is used, it is usually discharged from the drain into a sewer.

It is to be understood that the term "fluid" is used generically to designate various liquids or gases employed in cleaning, treating, drying, or rinsing parts, including chemical solutions employed in cleaning and/or rinsing parts as well as such compounds used for coating or descaling parts.

It is thus seen that a new and efficient multi-stage cleaning or washing device is hereby provided, whereby all of the aforesaid objectives of the invention are accomplished.

It is to be understood that the invention is not limited to the exact details of construction, operation, or exact materials or embodiments shown and described, as obvious modifications and equivalents will be apparent to one skilled in the art, and the invention is therefore to be limited only by the scope of the appended claims.

I claim:

1. In a machine for cleaning parts, the combination of a plurality of compartments mounted for rotation on a horizontal axis and for substantial free movement in space, fluid-injecting means operatively associated with said compartments for supplying fluid therein, means for guiding the parts between adjacent compartments, a drain operatively associated with said compartments for discharging fluid therefrom, means for imparting alternating waves of energy to said compartments for moving the mass of parts therein in an orbital motion and for increasing the turbulence and mechanical action around the parts, and means for rotating said compartments from one position to another so that the parts flow in and out of adjacent compartments successively.

2. A cleaning machine comprising a housing mounted for rotation on a horizontal axis, a cleaning compartment in said housing having an opening adapted to receive uncleaned parts, a rinsing compartment in said housing adapted to receive parts from said cleaning compartment when said housing is rotated to a rinsing position, a first fluid-injecting means operatively associated with said cleaning compartment for supplying fluid to parts therein, a second fluid-injecting means in said housing for supplying fluid to parts entering said rinsing compartment, a drain connected to each of said compartments for removing fluid therefrom, discharge means communicating with said rinsing compartment for discharging parts from said housing when said housing is rotated from the rinsing position to a cleaning position, vibration generating means secured to said housing for imparting vibrations thereto in at least one position of rotation, and means operatively connected to said housing for rotation thereof to the rinsing position and to the cleaning position.

3. In a cleaning machine, the combination of a cleaning compartment and a rinsing compartment attached to and communicating with each other and rotatably mounted as a unit for substantial free movement in space, fluid-injecting means operatively associated with said compartments for injecting fluid into at least one of said compartments, a drain connected to said compartment served by said fluid-injecting means for removing fluid therefrom, vibration generating means for imparting vibrations to said cleaning compartment, and means for rotating said compartments.

4. A cleaning machine comprising a housing journaled for rotation on a horizontal axis and including means defining a cleaning compartment and means defining a rinsing compartment, fluid-injecting means in said compartments adapted to supply fluid therein, a drain for each of said compartments for removing fluid therefrom, said housing being provided with an opening for charging said cleaning compartment with parts and an opening for discharging said parts from said rinsing compartment, vibration generating means mounted on said housing for imparting vibrations thereto in at least one position of rotation, and means operatively connected to said housing for rotation thereof.

5. A cleaning machine comprising a series of housings mounted for rotation as a unit on a horizontal axis and for substantial free movement in space, a cleaning compartment in each of said housings of the series having an opening adapted to receive uncleaned parts, a rinsing compartment in each of said housings of the series communicating with its respective cleaning compartment for receiving parts when said series of housings is rotated to a rinsing position, fluid-injecting means disposed in each of said cleaning compartments for supplying cleaning fluid to the uncleaned parts, fluid-injecting means in each of said housings operatively associated with each of said rinsing

compartments for supplying rinsing fluid to the parts, a drain connected to each of said compartments of the series for discharging fluid therefrom, means for transferring parts from one housing to the succeeding housing, discharge means communicating with the rinsing compartment of the last housing of the series for discharging parts therefrom when said housing is rotated to a discharge position, vibration generating means operative to impart vibrations to said housings in at least one position of rotation, and means operatively connected to said series of housings for rotation thereof from one position to another.

6. In a cleaning machine, the combination of a housing mounted for rotation on a horizontal axis and for substantial free movement in space, a cleaning compartment in said housing having an opening adapted to receive uncleaned parts, a rinsing compartment in said housing having an opening adapted to receive parts from said cleaning compartment when said housing is rotated to a rinsing position, a partition disposed in said housing for dividing said compartments into a plurality of sections, fluid-injecting means provided in each of said sections for supplying fluid therein, transfer means mounted in said housing for transferring parts from one section to the succeeding section, discharge means connected with the last section of said housing for discharging parts therefrom, drain means provided in each section of the housing for discharging fluid therefrom, vibration generating means secured to said housing for imparting vibrations thereto in at least one position of rotation, and means operatively associated with said housing for rotation thereof to the rinsing position and to a cleaning position.

7. A multi-stage cleaning machine comprising a series of housings, each housing including a bottom compartment and a top compartment secured together for rotation on a horizontal axis and mounted for substantial free movement in space, fluid-injecting means disposed in each of said housings of the series for injecting fluid therein, means for supplying fluid to said fluid-injecting means, drain means connected to each of said housings of the series for removing fluid therefrom, said first housing of the series being provided with an opening for receiving parts, discharge means connected to the last housing of the series for discharging parts therefrom, vibration generating means mounted to said series of housings for imparting alternating waves of energy thereto in various positions of rotation, means operatively connected to said series of housings for rotation thereof from one position to another, transfer means mounted in said housings for transferring parts from one housing to a succeeding housing of the series when said series is rotated from one position to another, and means for directing parts from the bottom to the top of each housing of the series.

8. In a cleaning machine, the combination of a housing mounted for rotation on a horizontal axis, a cleaning compartment in said housing having an opening adapted to receive uncleaned parts, a rinsing compartment in said housing adapted to receive parts from said cleaning compartment, a conduit mounted in said housing having fluid-directing apertures along one side thereof extending substantially normal to the longitudinal axis thereof, means for supplying fluid to said conduit for spraying parts in said cleaning compartment, means for rotating said housing from a cleaning position to a rinsing position, a tube mounted in said housing having fluid-directing apertures along one side thereof extending substantially normal to the longitudinal axis thereof, means for supplying fluid under pressure to said tube for rinsing parts entering said rinsing compartment, a drain in each of said compartments for removing fluid therefrom, discharge means communicating with said rinsing compartment for discharging parts from said housing, vibration generating means secured to said housing for imparting vibrations thereto in at least one position of rotation, and means operatively associated with said housing for rotation thereof from one position to another.

9. In a multi-stage cleaning machine including a housing mounted for rotation on a horizontal axis, said housing having a cleaning compartment and a rinsing compartment, a first fluid-directing means disposed in said housing for supplying fluid to said cleaning compartment, a second fluid-directing means disposed in said housing for supplying fluid to said rinsing compartment, a plurality of drains connected to said housing for discharging fluid therefrom, vibration generating means for imparting vibrations to said housing in at least one position of rotation, and means for rotating said housing from a cleaning position to a rinsing position and back to the cleaning position, the combination of a partition disposed in said housing for dividing said cleaning compartment and said rinsing compartment into sections, a baffle mounted in each section of the housing for preventing the return of parts from the rinsing compartment section to its respective cleaning compartment section, a duct disposed in said housing and communicating with an opening provided in said partition for transferring parts from the first section of the rinsing compartment to the succeeding section of the cleaning compartment, and the last section of the housing being provided with an opening for discharging parts therefrom.

10. A multi-stage cleaning machine comprising a series of housings mounted for rotation as a unit on a horizontal axis, a cleaning compartment in each of said housings having an opening adapted to receive uncleaned parts, a rinsing compartment in each of said housings communicating with its respective cleaning compartment for receiving parts when said series of housings is rotated from a cleaning position to a rinsing position, a first fluid-directing means provided in each housing for supplying fluid to each cleaning compartment thereof when said housing is in the cleaning position of rotation, a second fluid-directing means provided in each housing for supplying fluid to each rinsing compartment thereof when said housing is in the rinsing position of rotation, a drain for discharging fluid from each of the cleaning and rinsing compartments, each housing wall between adjacent rinsing compartments being provided with an opening to receive parts, and the housing wall constituting the outer wall of the last rinsing compartment of the series being provided with an opening for discharge of parts, a first baffle in each of said rinsing compartments, said first baffle in said rinsing compartment of all except the last housing of the series communicating with said opening in said housing wall between adjacent rinsing compartments for guiding parts therethrough, said first baffle in said rinsing compartment of the last housing of the series communicating with said opening in the housing wall constituting the outer wall of the last rinsing compartment in the series for guiding the discharge of parts therethrough, a duct communicating with said opening in each housing wall between adjacent rinsing compartments for transferring parts from said rinsing compartment of the one housing into the cleaning compartment of the next housing of the series, a second baffle in each of said housings interposed between said cleaning compartment and its respective rinsing compartment for preventing the flow of parts from said rinsing compartment into its respective cleaning compartment when said series of housings is rotated from the rinsing position to the cleaning position, vibration generating means for imparting vibrations to said series of housings in at least one position of rotation, and means for rotating said series of housings to the rinsing position and to the cleaning position.

11. A multi-stage cleaning machine comprising a series of housings mounted for rotation as a unit on a horizontal axis and having a cleaning position of rotation and a rinsing position of rotation, a cleaning compartment in each of said housings having an opening adapted to receive uncleaned parts, a rinsing compartment in each of

said housings communicating with its respective cleaning compartment for receiving parts when said series of housings is rotated from a cleaning position to a rinsing position, a first fluid-directing means provided in each housing of the series for supplying fluid to each cleaning compartment thereof when said housing is in a cleaning position of rotation, a second fluid-directing means provided in each housing of the series for supplying fluid to each rinsing compartment therein when said housing is in a rinsing position of rotation, means for supplying fluid under pressure to said fluid-directing means, means for discharging fluid from various compartments of the housings, each housing wall between adjacent rinsing compartments being provided with an opening to receive parts, and the housing wall constituting the outer wall of the last rinsing compartment of the series being provided with an opening for discharge of parts, a first baffle in each of said rinsing compartments, said first baffle in said rinsing compartment of all except the last housing of the series communicating with said opening in said housing wall between adjacent rinsing compartments for guiding parts therethrough, said first baffle in said rinsing compartment of the last housing of the series communicating with said opening in the housing wall constituting the outer wall of the last rinsing compartment of the series for guiding the discharge of parts therethrough, a duct communicating with said opening in each housing wall between adjacent rinsing compartments for transferring parts from said rinsing compartment of the one housing into said cleaning compartment of the next housing of the series, a second baffle in each of said housings interposed between said cleaning compartment and its respective rinsing compartment for preventing the flow of parts from said rinsing compartment into its respective cleaning compartment when said series of housings is rotated from the rinsing position to the cleaning position, vibration generating means for imparting vibrations to said series of housings in at least one position of rotation, and means for rotating said series of housings to the rinsing position and to the cleaning position.

12. A multi-stage cleaning machine comprising a series of housings mounted for rotation as a unit on a horizontal axis, a cleaning compartment in each of said housings having an opening adapted to receive uncleaned parts, a rinsing compartment in each of said housings communicating with its respective cleaning compartment for receiving parts when said series of housings is rotated from a cleaning position to a rinsing position, a first fluid-directing means provided in each housing for supplying fluid to each cleaning compartment thereof, a second fluid-directing means provided in each housing for rinsing the parts entering each rinsing compartment thereof, means for supplying fluid under pressure to each of said fluid-directing means, a drain connected to each of said compartments for discharging fluid therefrom, a first baffle in each of said rinsing compartments communicating with an opening provided in a side of each of said housings of the series for guiding parts therethrough, a duct communicating with each of said openings for transferring the parts from the rinsing compartment of all except the last housing of the series into the cleaning compartment of the next housing of the series and from the rinsing compartment of the last housing of the series into a discharge chute, a second baffle in each of said housings interposed between said cleaning compartment and its respective rinsing compartment for preventing the flow of parts from said rinsing compartment into its respective cleaning compartment when said series of housings is rotated from the rinsing position to the cleaning position, vibration generating means for imparting vibrations to said series of housings in various positions of rotation, and means for rotating said series of housings from the cleaning position to the rinsing position and back to the cleaning position.

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