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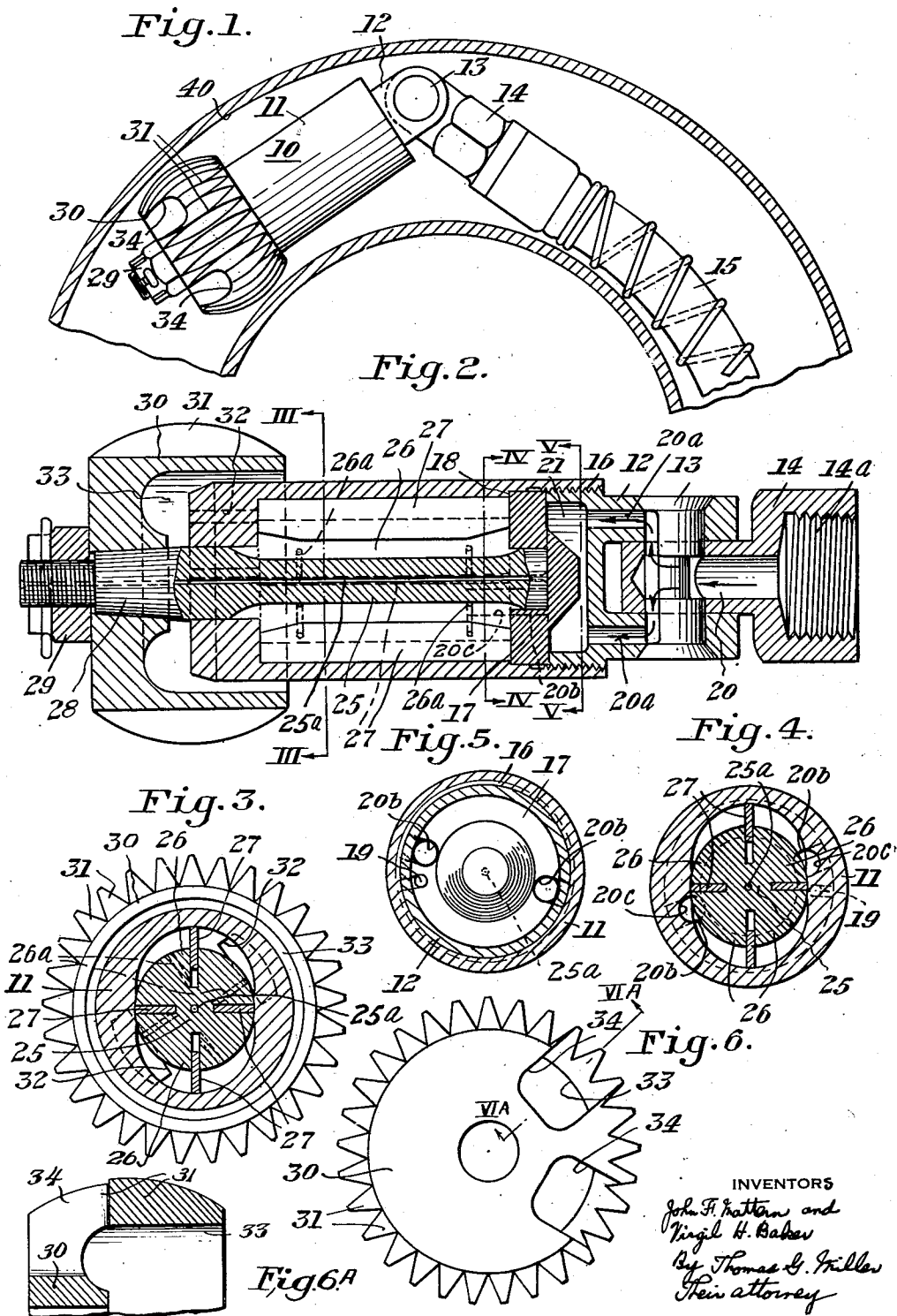
J. F. MATTERN ET AL

2,178,801

TUBE CLEANER

Filed Dec. 28, 1937

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 7.

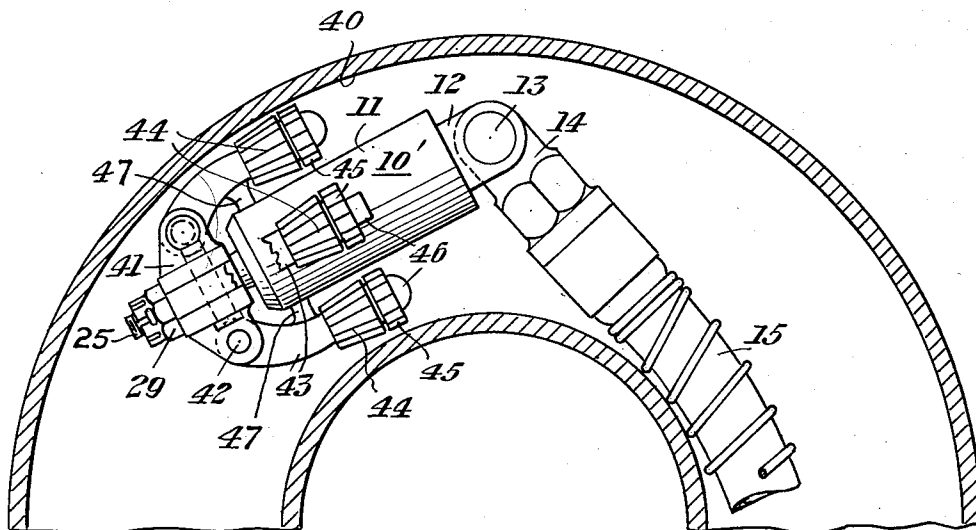
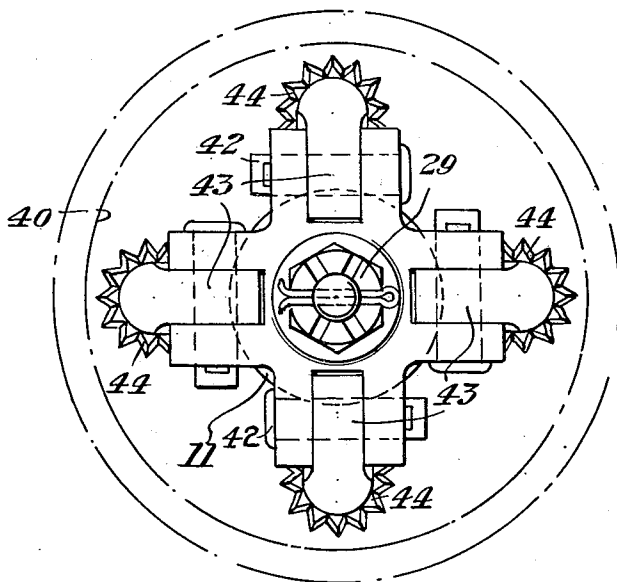


Fig. 8



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UNITED STATES PATENT OFFICE

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TUBE CLEANER

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15 Claims. (Cl. 15—104.12)

This invention pertains to motor driven tube cleaners, and more particularly, to tube cleaners of flexible construction.

At the present time, small diameter tubes are being increasingly used in boiler, heat exchange, and petroleum distillation applications. The element of cost has been important in this connection since it is difficult to fabricate non-corrosive and stainless steels in heavy walls and large diameters, and since special steels are being used due to higher temperature and pressure conditions. It is also easier to maintain turbulent flow conditions on the liquid side of a heat exchange wall with small diameter tubing. Then, too, tubes of this type are much easier to fabricate and bend.

In boiler work, the tubes are subject to scale, and in petroleum refining work, are subject to coking, while in general process work they may, in addition, be plugged with products of corrosion. It is thus necessary to find some practical and effective way for cleaning them.

Frequently in furnace applications, either in still or boiler work, the tubes are exposed to radiant heat and are intended to absorb it. They are usually backed by some refractory material in order to provide radiation to the rear as well as to the front of the tubes. In order to protect the refractories, the tubes are spaced close together and a line of fittings known as return bends are employed. The return bends are merely elbows of 180° arc designed to clamp on the tubes; being of extremely short radius, the tubes are brought closely together.

Frequently in heat exchange work, substantially the same construction is employed, short radius bends being provided in order to group the tubes closely together and to reduce the volume of the enclosing structure which is, of course, expensive. In many cases the tubes themselves are bent to short radii, this being a permissible feature with small tubes, eliminating the return bend. In refinery and boiler work, the tubes are bent into all sorts of shapes to avoid baffles for directing the gas flow, and there is no uniform pattern among manufacturers.

From the above description, it will appear that a cleaning device for cleaning tubes of the above classification must be able to negotiate a short radius bend. Tube cleaning practice originally contemplated the cleaning of bends where large diameter tubes were employed. Heads for this type of work have been found to be entirely impractical for the cleaning of narrow diameter tubes. In the old conventional cleaning combi-

nations, operation was only possible where the flexure was sufficient to permit transmission of rotation; and, if the deflection became sufficiently great, the head tended to revolve completely about the motor axis, and being restrained in such motion, would stall. There is also considerable wear on the flexible shaft and a great waste of power.

We have found that the axial length over which rigidity applies is very important. This might be called the "wheel base" of the individual parts. When the rigid parts lie in the tube, they occupy a chord in the bend and this chord must be short enough to prevent binding. Also, the chord of the head combination must be such that intersecting chords represented by the motor and head must intersect at a sufficiently large angle, in order that rotation can be transmitted through the joint. From this standpoint, therefore, the rigid length or "wheel base" is a very important factor.

We have conceived the idea of combining the rigid length of the motor and the head in one part by suitably mounting the cutter on the front end of the motor shaft and permitting the cutter to at least partially encircle the motor in such a manner that sufficient cutting surface will be provided without materially increasing the rigid length of the combination. We were immediately faced with the problem of exhausting the air from the motor (if a fluid motor is being employed) and found it necessary to provide suitable venting. We found that the location of vent holes and their arrangement was very important.

We also found that the combination would work in unbelievably sharp or short bends and in very narrow diameter tubes when a suitable joint was provided at the rear of the combination between the motor and the fluid supply hose. Although the hose normally has considerable ability to bend, we found that in bending it produced a reaction on the motor combination and did not allow the combination to lie freely in the tube to the extent that its axial length would permit, and that the reaction from the bent hose forced the head against the outer tube wall. In providing this joint, we preferred a somewhat conventional type having a single plane of freedom, in that it was found that this type would provide the desired results with a minimum leakage of air; other suitable types such as a two-plane joint can be employed.

We then discovered that the cutter head combination would lie in one place and not cover the

whole inside of the tube. Of course, it will be recognized that the cutter in all cases is necessarily smaller than the diameter of the tube. Thus, we devised a method whereby the cutter would in effect move in an eccentric or vibratory path to whip against the inside portions of the tube. We were able to combine this idea with the exhausting of the fluid from the motor chamber.

It has been an object of our invention to provide a suitable cleaning head for small diameter tubes and/or for tubes having relatively sharp bends;

Another object of our invention has been to devise an inexpensive, simple, and effective, as well as efficient form of motor-driven cleaning device having improved characteristics;

Another object of our invention has been to devise an improved method of operating a cleaner device within a tube structure;

A further object of our invention has been to provide a tube cleaning device particularly suitable for the requirements previously discussed above;

A still further object has been to devise a compact and efficient form of flexible cleaning device of such a nature that rigid portions thereof are combined in such a manner that a minimum "wheel base" results;

These and many other objects of our invention will appear to those skilled in the art from the drawings, the description thereof, and the appended claims.

In the drawings:

Figure 1 is a side view of a cleaner device constructed in accordance with the principles of our invention in an operating relationship with respect to a tube bend;

Figure 2 is a vertical side cross-sectional view of the device of Figure 1;

Figures 3, 4, and 5 are end sectional views taken along the lines III—III, IV—IV, and V—V, respectively, of Figure 2;

Figure 6 is a front view in elevation showing a detail of a cleaner element of the embodiment of our invention disclosed in Figures 1 and 2;

Figure 6a is a sectional detail taken along the line VIA—VIA of Figure 6;

Figure 7 is a side view of a modified form of cleaner device; and

Figure 8 is an enlarged end elevation of the device of Figure 7.

The numeral 10 indicates an embodiment of our invention chosen for the purpose of illustration, see Figures 1 and 2. The device or combination 10 is provided, as shown, with a casing head portion 11, preferably of cylindrical outline. One end of the casing 11 is open, as shown particularly in Figure 2, and is provided with inner thread portions 16 for removably receiving a threaded cap portion 12 of a hinge joint 13.

The hinge joint 13 pivotally connects the cap portion 12 to a connector portion 14. The connector 14 is inwardly threaded at 14a to receive a male threaded portion of a flexible hose 15. The hose 15 is shown reinforced with a wire winding to protect it and at the same time to give it stiffness, see Figure 1.

A suitable fluid motor is mounted in the casing 11 and includes a support or axle shaft 25 having rotor segments 26 securely mounted thereon; the shaft 25 and segments 26 are integral in the construction shown. The segments 26 are preferably separated by spaced-apart or slotted portions that receive sliding vanes or paddles 27. For

producing the desired vane action, two halves of the inner periphery of the casing 11 form intersecting circles in continuation, in order that opposite vanes will be simultaneously actuated during the rotation of the device. Due to the symmetrical arrangement of the chamber, the rotative movement produced is evenly distributed. Fluid is introduced into the motor through the connector 14, the connection 13, the cap 12, and through a positioning washer element 17. As noted, the flow is from passageway 20 to passageway 20a to chamber 21 through ports or passageways 20b into the chamber of the casing 11. Exhaust ports or slits 32 are provided at opposite ends of the casing and are preferably symmetrically located, see particularly Figure 3.

A cleaner element 30 having suitable cleaner portions or teeth 31 about the outer periphery thereof is mounted on a tapered end portion 28 of the axle shaft 25 and is removably secured thereto by a suitable cotter nut 29. As noted, the inner wall or peripheral portions of the cleaner element 30 are slotted out to provide a fluid exhaust chamber 33. The chamber 33 is somewhat annulus-like in shape adjacent the front wall portion of the cleaner element 30 and is somewhat cylindrical about the outer wall portion of the casing 11. Adjacently positioned exhaust ports 34 are cut out or provided in the outer peripheral portions 31 of the cleaner element 30, see particularly Figure 1. They, of course, communicate with the exhaust chamber 33.

The rotor-positioning, removable washer 17 is mounted as shown upon an inset peripheral ledge portion 18 of the casing 11. The washer 17 is slotted to receive a pin 19 that extends outwardly from the ledge 18 to prevent its rotation. It is also centrally chambered to rotatably receive and to act as a bearing for one end of the rotor shaft 25. The cap 17 is removably held in position by the threaded cap 12. The front end of the casing 11 serves as a bearing for the portion of the axle 25 extending therethrough. It will thus be seen that the entire combination may be readily assembled, disassembled, and reassembled.

In operation, the actuating fluid moves along the paths indicated by the arrows through the passageways or ports 20 and 21a, chamber 21 and ports or passageways 20b to actuate the vanes of the motor and produce rotation of the rotor 26 and, of course, of the axle 25. This in turn rotates the cleaner element 30 which is securely but removably secured to the tapered portion 28. Fluid exhausts, as previously explained, from the chamber 33 through the ports 34. The unbalance produced by this location, arrangement, and/or construction of the ports 34 causes the cleaner element to move somewhat eccentrically and to produce a whipping action. As a result, the entire inner periphery of the tube structure 40 is suitably cleaned as the combination is advanced therealong. The whipping or eccentric action of the unit produces what may be termed a dynamically unbalanced rotation. It will be noted that the whipping or eccentric action is about the pivot point 13 rather than about the motor unit, itself. The cleaner structure or element 13 also surmounts at least a portion of the motor casing 11. This produces a compact form of unit having a high efficiency of cleaning action.

Although we have produced the whipping action without eccentrically mounting the cleaner element, we contemplate doing this, and also contemplate providing the cleaner element with

off-balanced counter-weight portions. It will be noted, of course, that the weight of the cleaner element 31 is off-balanced due to the location of the ports unsymmetrically with respect thereto, and that the exhaust of fluid through such ports also aids the whipping action.

As shown particularly in Figure 3, we have provided pairs of spaced-apart communicating ports or holes 26a that extend from the outer periphery of each stator segment 26 inclining downwardly therethrough to connect with or vent the bottom of the spacing of the vane or paddle slots separating one segment from the other. These holes, in effect, lubricate the vanes as well as the stator and produce a smooth and uniform rotary action within the casing 11; they also prevent paddle or vane piston effects. The rotor shaft portion 25 is shown drilled out through its entire length and vented at its front end; the hole thus provided vents the rear bearings to provide a pressure difference thereacross sufficient to provide oil therefor.

In Figures 7 and 8 of the drawings, we have shown a modified form of our invention. In this embodiment, for the purpose of simplifying the description thereof, we have designated similar parts by corresponding numeral designations of the previously described embodiment of our invention. In this form, a spider or head 41 is secured on the outwardly extending end of the axle shaft 25 and is secured thereto by the cotter nut 29. In other words, the spider 41 is mounted in place of the cutter element construction 31 of the embodiment of our invention shown in Figures 1-6, inclusive. Backwardly extending and outwardly swinging arms are pivotally mounted on bifurcated portions of the spindle 41 by means of removable pivot pins 42. As shown, each pivot pin 42 may have a cotter opening adjacent the extending end thereof for receiving a wedge or cotter element, as shown particularly in Figure 8. We have also mounted suitable cleaning and/or cutter elements 44 and 45 on the extending end portions of the swinging arms 43 by means of suitable cutter pins 46. The pins 46 may be removably mounted in the customary manner.

To prevent the arms 43 as well as the cutter elements 44 from striking against the casing 11 of the motor 10, each arm is provided, as shown, with an inwardly projecting contact lug or stud 47. The stud 47 permits the arms to swing outwardly but limits their maximum inward swing.

In operation, the motor rotates the shaft 25 and the spider or head 41 which in turn rotates the cleaner elements 44 and 45. The centrifugal action of the rotary force, of course, tends to throw the cleaner elements outwardly against the inner wall portions of the tubing 40 being cleaned.

In both embodiments of our invention, any suitable form of motor may be employed and also any suitable form of connector device. However, we prefer a connector device for connecting the motor to the source of actuating medium that permits a substantially 180° pivotal movement between the elements connected.

Although we have for the purpose of illustration shown certain embodiments of our invention, it will be apparent to those skilled in the art that many other suitable embodiments may be employed and that modifications, additions, subtractions, and/or combinations therewith may be made without departing from the spirit and scope of the invention as indicated by the appended claims.

We claim:

1. In a motor driven tube cleaner for sharp radius bends, a motor unit having rotative and stationary parts including an extending shaft connected to said rotative parts, actuating means for said rotative parts, a cleaner structure securely mounted on said shaft and being actuated thereby, said cleaner structure having a cleaner portion constructed and arranged to extend over and above a portion of said motor unit and to move about stationary parts thereof.

2. In a tube cleaner as defined in claim 1, means for producing an eccentric movement of said cleaner structure and said motor unit during rotation of said cleaner structure.

3. In a motor driven tube cleaner, rotative means, a rotatable cleaner element structure operably connected to said means, at least one fluid passage opening through said cleaner element structure, and means for supplying fluid to said passage, said passage being arranged and located to impart a dynamically unbalanced rotation to said cleaner structure.

4. In a motor driven tube cleaner, rotative means, means for supplying an actuating agency to said rotative means, a rotatable cleaner element operably associated with said rotative means, at least one offsetly located port in said cleaner element, and means for exhausting such actuating agency substantially radially through said port, said port being adapted and arranged to impart a dynamically unbalanced rotative movement to said cleaner element.

5. In a motor driven tube cleaner device, a motor having a suitable casing, said motor having rotatable and non-rotatable portions, a spider positioned adjacent a forward end of the cleaner device and having arms extending backwardly over said casing, said spider being operably connected to the rotatable portions of said motor for rotation therewith.

6. In a motor driven tube cleaner device as defined in claim 5 wherein said arms are swinging arms.

7. In a motor driven tube cleaner, a motor having a body portion, a hinge joint connected to said body portion and supplying motive fluid to said motor unit, said motor having a rotatable shaft extending beyond said body portion, a spider mounted on said extending shaft for rotation therewith, swinging arms pivotally mounted on said spider and extending to positions above and about said body portion, and cleaner elements operably mounted on said arms.

8. In a motor driven tube cleaner for sharp radius bends, a motor casing, a hinge joint having a fluid passageway extending therethrough and connecting with said motor casing, said hinge joint having a pivot pin construction to provide a single plane of movement, a flexible hose connected to said hinge joint and supplying motive fluid through said passageway to said casing, a motor in said casing, a shaft operably connected to said motor and extending from said casing, and a cleaner element structure operably mounted on the extending portion of said shaft and being rotatably mounted with respect to said casing, said cleaner element structure being driven by said motor and said shaft, said cleaner element structure being operably positioned about a portion of said casing.

9. In a motor driven tube cleaner, a motor having a suitable casing, flexible means adjacent one end of said casing for supplying motive fluid to said motor, an exhaust passage in said casing adjacent an opposite end thereof, a cleaner element

operably mounted about said opposite end of said casing and forming a fluid exhaust chamber with respect to said casing, said cleaning element being operably connected to said motor for actuation thereby, and a pair of exhaust ports in said cleaner element in fluid communication with said passage and adjacently spaced with respect to each other and unsymmetrically spaced with respect to said cleaner element.

10. In a motor driven tube cleaner, a motor having a suitable casing, means supplying motive fluid through said casing to said motor for actuating said motor, a cleaner element surrounding at least a portion of said casing and being operably and concentrically mounted with respect to said casing, said cleaner element being actuated by said motor, and said cleaner element being constructed and arranged to rotate eccentrically with respect to a tube being cleaned.

11. In a motor driven tube cleaner, a motor casing having a pair of spaced-apart head portions, a motor in said casing, a hinge joint, passageways in one of said head portions communicating with said hinge joint for supplying motive fluid to said motor, said motor being constructed and arranged to rotate within said casing when actuated by the motive fluid, a cleaner element operably mounted over the other of said head portions, said cleaner element being operably connected to said motor for rotation thereby, and said cleaner element having an off-balanced weight for producing a whipping action during its rotation.

12. In a motor driven tube cleaner, a motor casing having a pair of spaced-apart head portions, a motor in said casing, means supplying motive fluid through one of said head portions to said motor, an exhaust passage in the other of said head portions for the motive fluid, a cleaner element operably mounted on said last-mentioned head portion and being constructed and arranged to be rotated by said motor, a fluid exhaust chamber formed between said cleaner element and said last-mentioned head portion, and a pair of exhaust ports extending through said last-mentioned head portion adjacent a peripheral portion thereof, said exhaust ports being

located in such a manner that the weight of said cleaner element is unevenly balanced about its center of rotation.

13. In a motor driven flexible tube cleaner, a motor casing having a motor chamber therein, a motor rotor having vanes operably mounted thereon, said rotor being operably mounted in said chamber, a pair of fluid passageways adjacent one end of said casing in communication with said chamber for supplying motive fluid to said rotor, a pair of exhaust passages adjacent an opposite end of said casing in communication with said chamber, a cleaner element operably connected to said rotor adjacent an end of said casing, said casing and said cleaner element being constructed and arranged to provide an exhaust chamber therebetween adjacent said exhaust passages, and exhaust ports in said cleaner element communicating with said exhaust chamber, said ports being constructed and arranged to produce a dynamically unbalanced rotative action of said cleaner element during actuation by said rotor.

14. In a motor driven tube cleaner, a casing, a fluid motor operably mounted in said casing, a flexible connector supplying motive fluid through said casing to said motor, a cleaner element having suitable cleaning portions about its periphery, said cleaner element being operably connected to said motor for actuation thereby and having a portion extending over said casing, an exhaust passage communicating with said motor and with an inner periphery of said cleaner element, and an exhaust port opening through the cleaning portions of said cleaner element and communicating with said exhaust passage.

15. In a motor driven tube cleaner, a motor having a suitable non-rotatable casing, a spider having swinging arms, said arms extending backwardly over said casing, at least one cleaner element carried by said swinging arms, said swinging arms being constructed and arranged to rotate with said motor and with respect to said casing.

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