Nov. 30, 1948. D. E. SCHOTT ET AL 2,455,273

SELF-PROPELLED TUBE CLEANER HAVING ADJUSTABLE TUBE-ENGAGING MEANS

Filed Jan. 18, 1947 3 Sheets-Sheet 1

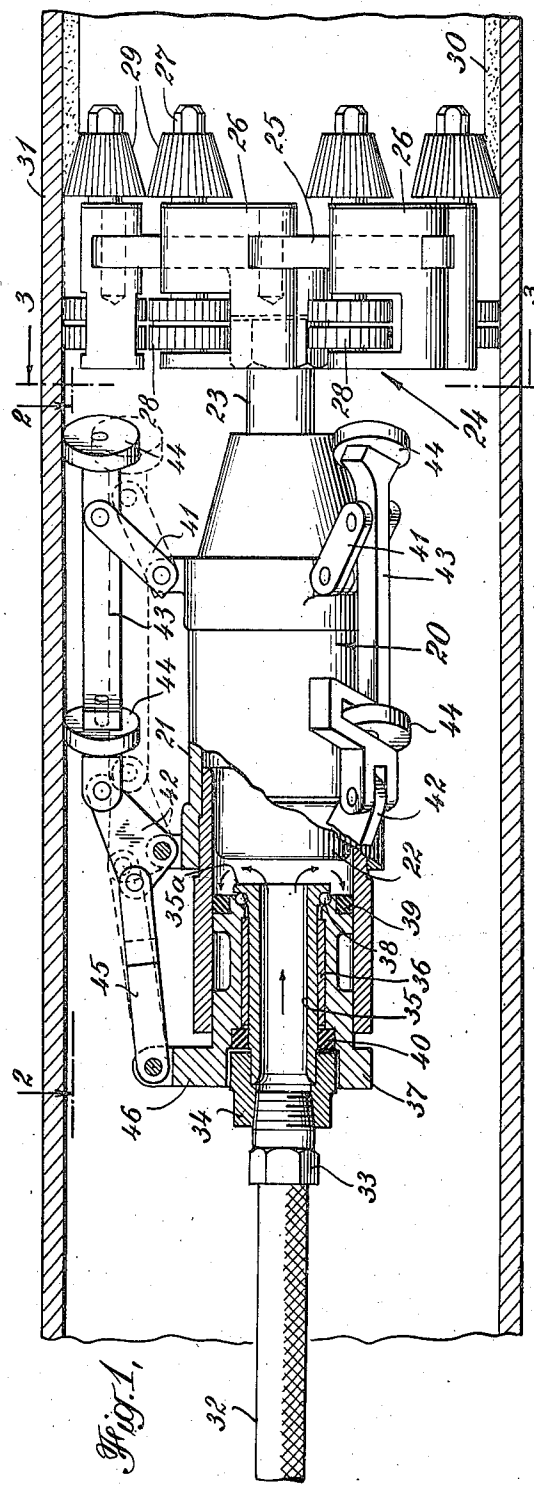


Fig. 1.

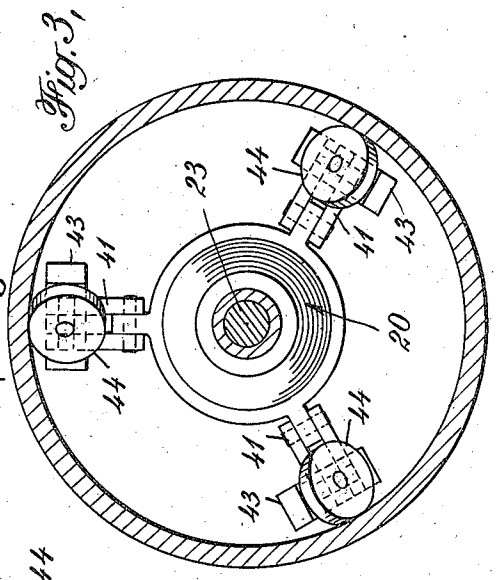


Fig. 3.

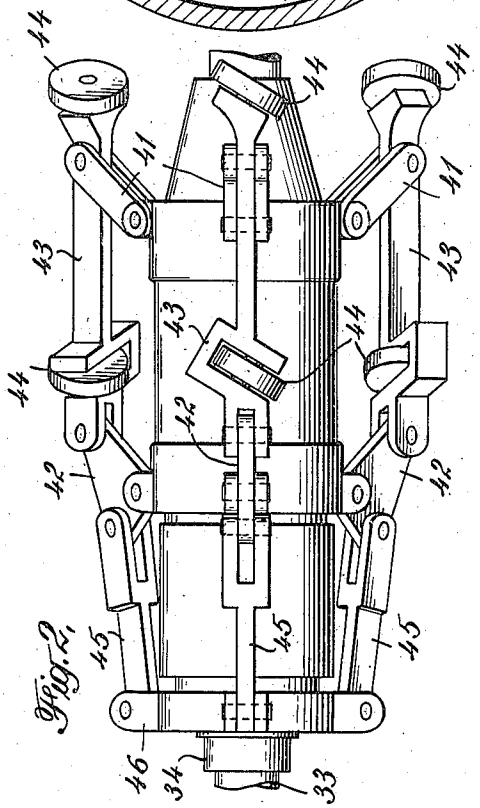


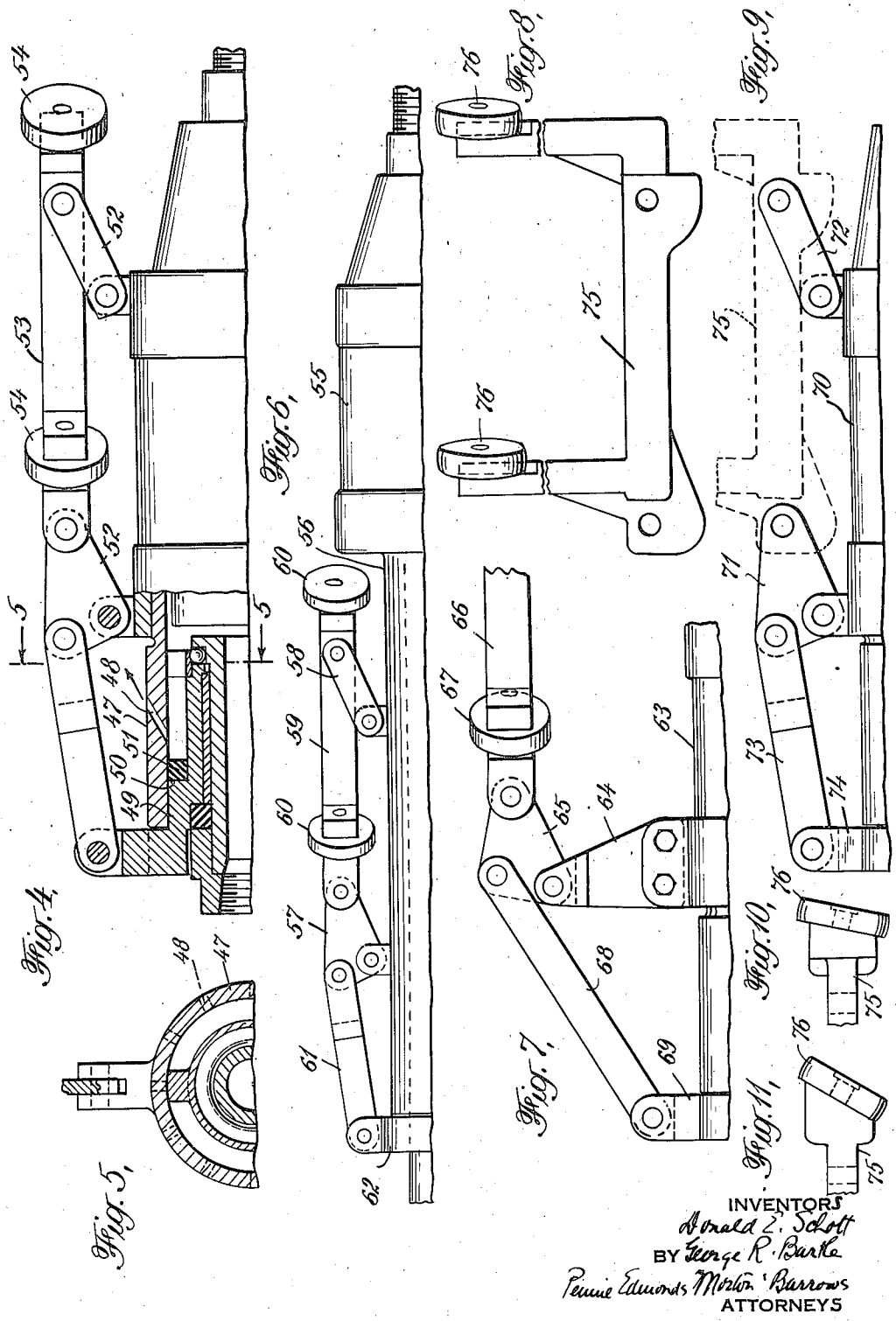
Fig. 2.

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Filed Jan. 18, 1947 3 Sheets-Sheet 2



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SELF-PROPELLED TUBE CLEANER HAVING ADJUSTABLE TUBE-ENGAGING MEANS

Filed Jan. 18, 1947 3 Sheets-Sheet 3

Fig. 12,

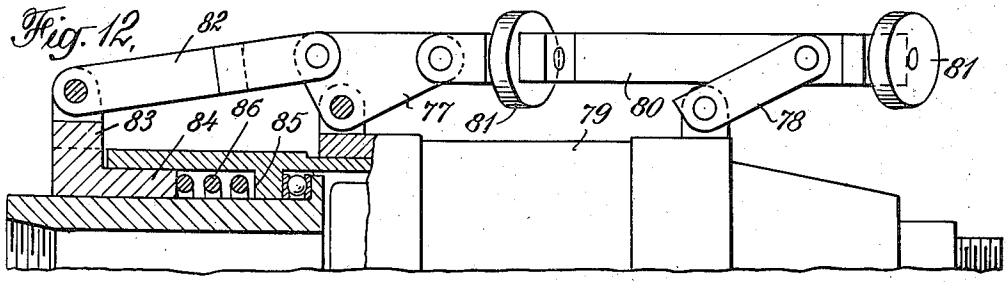


Fig. 13,

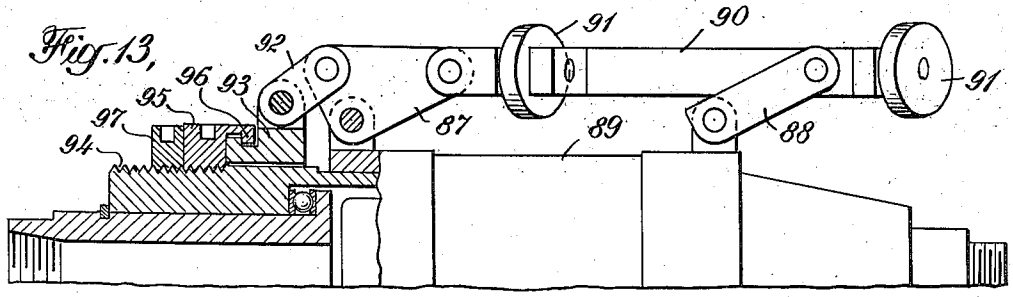


Fig. 14,

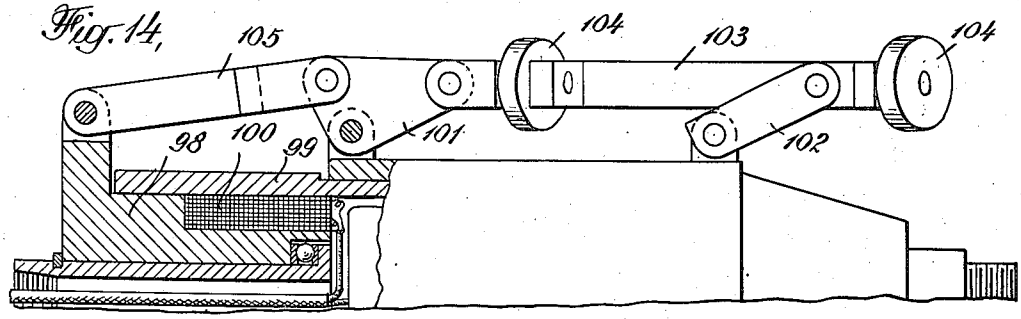


Fig. 15,

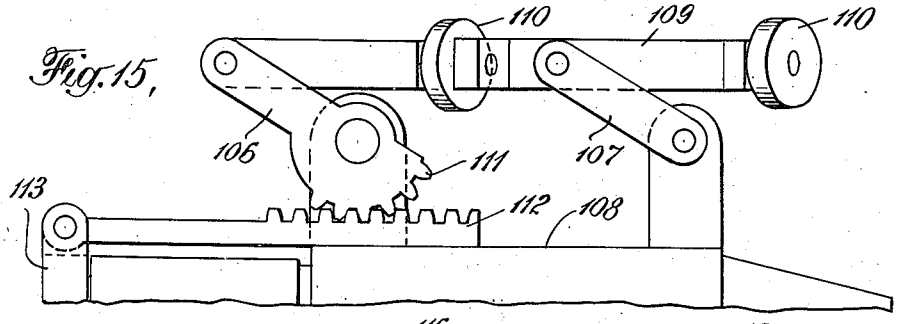
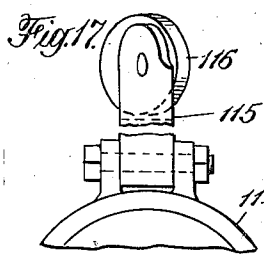


Fig. 17.



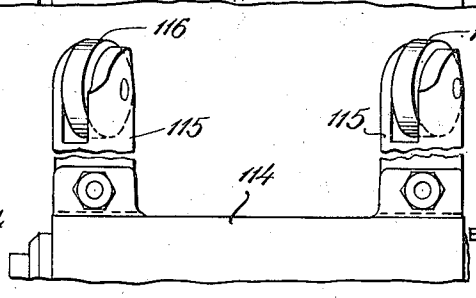
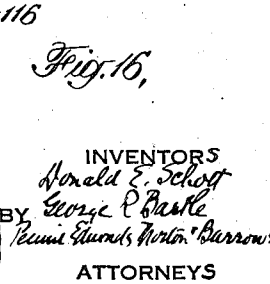


Fig. 16,



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SELF-PROPELLED TUBE CLEANER HAVING ADJUSTABLE TUBE-ENGAGING MEANS

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Application January 18, 1947, Serial No. 722,908

8 Claims. (Cl. 15—104.12)

1

This invention relates to apparatus for cleaning tubes by removal of scale and incrustations from the inner surfaces thereof. More particularly, the invention is concerned with a novel tube cleaning apparatus of the motor driven type, which may be employed in the cleaning of tubes of different internal diameter and operates to maintain the motor and cutter head centralized at all times. The new tube cleaner may be so constructed, that it will adjust itself automatically with respect to the diameter of the tube to be cleaned, and it advances automatically through the tube, as the cleaning progresses. In addition, the rotation of the motor resulting from counter-torque, which is a factor reducing the efficiency of prior tube cleaners, is greatly diminished in the new apparatus.

The tube cleaner of the invention comprises a motor, which is to be inserted endwise into the tube to be cleaned and may be fluid driven, as by compressed air or steam, or may be an electric motor. The motor includes a casing and a rotor, and the cutter head, provided with the cutters that attack and free the scale, is connected to the rotor. The motor is supported within the tube on rollers, that bear on the inner surface of the tube and are carried by a number of similar members mounted on the motor casing. The members are angularly spaced about the casing and are movable toward and away from he tube to cause the rollers to engage the tube. The members are connected together to move in unison and, preferably, they are urged toward the tube by the power supplied to the motor and, thus, support the motor in centralized position relative to the tube, regardless of the size thereof. The motor develops a counter-torque in operation tending to rotate the casing and the rollers are mounted in skewed relation to the tube axis, so that the counter-rotation of the casing caused by the counter-torque acts to advance the cleaner along a helical path through the tube. As the cleaner advances slowly and the rollers do not slip, the counter-rotation of the casing is slow and most of the power supplied to the motor is utilized to drive the cutter head.

For a better understanding of the invention, reference may be made to the accompanying drawings:

Fig. 1 is a view partly in elevation and partly in section of one form of the new tube cleaner;

Fig. 2 is a plan view of the cleaner shown in Fig. 1;

Fig. 3 is a sectional view on the line 3—3 of Fig. 1;

2

Fig. 4 is a partial elevational view, with parts broken away, of a modified form of the new cleaner;

Fig. 5 is a sectional view on the line 5—5 of Fig. 4;

Fig. 6 is a partial elevational view of another modified form of the new cleaner;

Fig. 7 is a partial elevational view of a modified form of a portion of the new cleaner;

Fig. 8 is an elevational view of a modified roller mounting that may be employed in the new cleaner;

Fig. 9 is a partial elevational view showing the manner of use of the roller mounting of Fig. 8;

Figs. 10 and 11 are plan views showing different roller arrangements that may be employed;

Figs. 12, 13, and 14, are partial elevational views with parts broken away of modified forms of the cleaner;

Fig. 15 is a partial elevational view of another modified form of the cleaner; and

Figs. 16 and 17 are, respectively, partial side and elevational views of another modified form of the new cleaner.

The cleaner illustrated in Fig. 1 is provided with an air motor 20, which includes a casing 21 enclosing a rotor 22 driving a shaft 23. The shaft extends out the forward end of the casing and a cutter head, generally designated 24, is mounted on the free end of the shaft. The cutter head may be of any desired type and the one illustrated includes a spider 25 having a number of legs, on which are mounted swinging frames 26. A pin 27 extends through openings in each frame and cutter wheels 28 are mounted on the pin at one side of the frame and a conical cutter 29 is mounted on the pin at the other side of the frame. When the cutter head is rotated, the frames swing outwardly relative to the spider and the cutter wheels operate to remove the incrustation 30 from the inner surface of the tube 31, within which the cleaner is operating.

The fluid for driving the motor is supplied through a hose 32 provided at its end with a fitting 33, which is threaded into a bushing 34 mounted on the end of a sleeve 35. Sleeve 35 lies within a bearing 36 which in turn lies within a sleeve 37 having a sliding fit within the motor casing. Sleeve 35 has an end flange 35a at its inner end which engages ball bearings 38 in a channel in the inner end of sleeve 37. A ring of packing 39 is seated in a channel at the inner end of the sleeve 37 and bears against the inner surface of the motor casing. A similar ring of packing 40 is mounted in a channel near the outer

end of sleeve 37 and bears against the outer surface of sleeve 35.

A plurality of arms 41, 42 are pivotally mounted on the outer surface of motor casing 21 and the arms are arranged in pairs with the arms of a pair aligned axially of the casing and the pairs spaced angularly about the casing. In the construction illustrated, there are three pairs of the arms on a 120° spacing. The ends of the arms of each pair are connected by a bar 43, on which rollers 44 are pivotally mounted in skewed relation to the axis of the casing. Each of the arms 42 is pivotally connected by a link 45 to a radial arm 46 on the one end of sleeve 37, which projects out of the casing. As sleeve 37 is moved endwise in the casing, arms 42 are swung toward or away from the inner surface of the tube and rollers 44 are caused to approach or move away from the tube wall.

In the operation of the cleaner illustrated in Fig. 1, the arms 41, 42 are swung inwardly toward the motor casing before the cleaner is inserted in the tube. When the cleaner is in place in the tube and fluid under pressure is supplied through the hose, the fluid acts on the rotor of the motor to drive the latter and the cutter head. At the same time, the pressure fluid acts on the packing ring 39 at the inner end of sleeve 37 and tends to force the sleeve outwardly from the casing. In such movement, the pull of the sleeve on links 45 causes arms 42 to swing away from the motor casing and the swinging movement of the arms continues until the rollers 44 engage the inner surface of the tube. As the arms 41, 42 are similar in mounting and effective length, the engagement with the rollers against the inner walls of the tube causes the motor to be held in centralized position with the tube. The rollers are kept in place by the pressure fluid and escape of the fluid is prevented by the packing rings 39, 40.

In the operation of the motor, it develops a counter-torque which tends to rotate the motor casing in a direction opposite to that of the cutter head. The rollers 44 are so skewed that, during the counter-rotation of the casing, the motor is caused to advance through the tube along a helical path determined by the angle of skew of the rollers. This advancing movement is resisted by the engagement of the conical cutters with the incrustation within the tube, so that the counter-rotation of the motor and the advancing movement of the cleaner are relatively slow. Accordingly, the major part of the power supplied to the motor is used for driving the cutter head. The rotation of the motor casing by the counter-torque is not transmitted to the hose, because sleeve 35, to which the hose is connected, is free to rotate in bearing 33. The hose, accordingly, has no tendency to twist and become kinked.

The modified construction illustrated in Fig. 4 differs from that shown in Fig. 1 in the following respects: The motor casing 47 is provided with a number of passages 48 which are inclined toward the forward end of the motor, at which the cutter head is mounted. The sleeve 49, which lies within the casing and corresponds to sleeve 37 in the Fig. 1 construction, is cut away on its outer surface to leave a shoulder 50 against which a packing ring may set, the ring lying outwardly of the inner ends of passages 48. With this arrangement, part of the fluid under pressure supplied to the motor to drive the latter acts on packing ring 51 and sleeve 49 to move the sleeve outwardly. The sleeve is connected to arms 52 mounted on the motor casing and connected by bars 53 carrying

skewed rollers 54. Outward movement of sleeve 49 swings the arms 52 to cause the rollers to engage the inner surface of the tube. Another part of the air under pressure escapes through passages 48 and blows away the debris freed from the tube wall by the cutting action.

In the modified construction shown in Fig. 6, the casing 55 of the motor has a rearward extension 56, on which are mounted aligned arms 57, 58 arranged in pairs, the arms of each pair being connected by a bar 59 carrying skewed rollers 60. Each of arms 57 is connected by a link 61 to a sleeve 62, which enters the extension 56 and corresponds in construction and operation to sleeve 37 in the Fig. 1 form. Air is supplied to the motor through extension 56 and part of the air acts on sleeve 62 to force it outwardly and urge rollers 60 into contact with the tube. With the Fig. 6 construction, the extension 56 may be detachable from the motor casing, so that different motors may be employed with the same supporting means, as may be desired.

When the tube to be cleaned is of large diameter, the cleaner supporting means shown in Figs. 7–11, inclusive, may be employed. In the Fig. 7 construction, the motor casing 63, or a detachable extension therefrom, is provided with pairs of radial arms 64 fixed in position and aligned lengthwise of the casing. A swinging arm 65 is pivotally mounted on one arm 64 of each pair and a swinging arm similar to arm 41 (Fig. 1) is pivotally mounted on the other arm 64 of each pair. The two swinging arms are connected by a bar 66 carrying skewed rollers 67 and each of the swinging arms 65 is connected by a link 68 to a sleeve 69, which has a portion lying within the casing 63 and corresponds in construction and mode of operation to sleeve 37, as shown in Fig. 1.

The construction shown in Figs. 8 and 9 may also be employed when the cleaner is to be used in a tube of large diameter. In this form of cleaner, the motor casing 70, or a detachable extension therefrom, has pairs of aligned swinging arms 71, 72 pivotally mounted thereon. Each of arms 71 is connected by a link 73 to a sleeve 74, which is similar in construction and mode of operation to the sleeve 37. A U-shaped member 75 is mounted in the ends of the arms 71, 72 of each pair and rollers 76 are mounted in skewed position at the outer ends of the legs of members 75. The members 75 are readily demountable from arms 71, 72, so that members having legs of different length may be employed with the cleaner, depending upon the diameter of the tube to be cleaned. When the tube is of large diameter and the members have long legs, the rollers 76 thereon have less skew than when the members 75 have shorter legs. The difference in skew in the two constructions is illustrated in Figs. 10 and 11 and is employed to prevent too great an advance for each counter-rotation of the motor casing in a large diameter tube.

In the construction illustrated in Fig. 1, the supporting means for the cleaner, consisting of the arms 41, 42 and bars 43 with their skewed rollers 44, are automatically operated by power supplied to the motor. Since the arms 41, 42 are similar and are swung outwardly in unison, the rollers make contact with the inner surface of the tube at all times and maintain the motor in centralized position. It is not necessary, however, that the supporting means be operated by power supplied to the motor and in the construction shown in Fig. 12, the supporting means are spring actuated. In the Fig. 12 cleaner pairs

of aligned arms 77, 78 are mounted on the casing 79 of the motor, or on an extension therefrom, and the ends of the arms of each pair are connected by a bar 80 carrying skewed rollers 81. Each of the arms 77 is connected by a link 82 to an arm 83 projecting radially from a sleeve 84, which extends into the motor casing. The casing has an internal shoulder 85 and a coil spring 86 is mounted within the casing to bear at one end against the shoulder 85 and at the other against the inner end of sleeve 84. The spring tends to force the sleeve 84 out of the casing at all times, so that arms 77, 78 are in outwardly extended position. With this construction, therefore, it is necessary to collapse the supporting means by force, before the cleaner is inserted in the tube, and thereafter, when the supporting means are freed, the spring 86 acts through sleeve 84 to swing arms 77, 78 outwardly to cause the rollers 81 to engage the inner surface of the tube.

A modified manually operated construction is shown in Fig. 13, in which pairs of aligned swinging arms 87, 88 are mounted on the motor casing 89, or on an extension therefrom, and the ends of the arms of each pair are connected by a bar 90 carrying skewed rollers 91. Each of the arms 87 is connected by a link 92 to a ring 93, which encircles the motor casing 89 at one end. A portion of the casing is externally threaded, as indicated at 94, and a nut 95 is screwed upon the threaded portion of the casing, the nut having a flange 96, which enters the circumferential groove in the ring 93. By turning the nut 95, the ring 93 may be moved lengthwise of the casing to swing the arms 87, 88 outwardly, so that the rollers 91 will fit snugly against the internal surface of the tube to be cleaned; thereafter, nut 95 is held tightly in position by a lock nut 97.

When the tube cleaner is provided with an electric motor, the supporting means may be electrically actuated and such a construction is shown in Fig. 14. In this form of the cleaner, a sleeve 98 is mounted within the casing 99 of the motor at one end. The portion of the sleeve within the casing is formed with a circumferential channel, in which is seated a solenoid 100, and the end of the casing is so polarized, that when current is supplied to the solenoid, it tends to move the sleeve 98 out of the casing. Pairs of aligned arms 101, 102 are mounted for swinging movement on the casing and the ends of the arms of a pair are connected by a bar 103 carrying skewed rollers 104. Each of arms 101 is connected by a link 105 to sleeve 98, so that outward movement of sleeve 98 tends to swing arms 101 and 102 to bring the rollers 104 into contact with the interior of the tube and, thus, maintain the motor in centralized position.

In all of the constructions above described, the skewed rollers are mounted in pairs on a bar supported in swinging arms, one of which is connected by a link to a movable sleeve. Instead of using this construction, that illustrated in Fig. 15 may be employed, in which pairs of aligned arms 106, 107 are mounted on the outside of the casing 108 of the motor with the ends of the arms of a pair connected by a bar 109 carrying skewed rollers 110. Each arm 106 has a hub provided with teeth 111, which mesh with the teeth of a rack 112 connected to a sleeve 113. The sleeve is mounted in the motor casing and can be moved endwise by power, as in the constructions shown in Figs. 1 and 14, or manually, as in the construction shown in Fig. 13. Endwise movement of the sleeve and the racks connected thereto causes arms 106 to swing and thus move rollers 110 toward or away from the tube.

In the constructions above described, the supporting means for the cleaner are adjustable, so that the cleaner can be employed in tubes of different internal diameter. Certain advantages of the invention may be obtained, however, in a construction, in which the supporting means are not so adjustable. For this purpose the motor casing 114 may be provided with rigid arms 115 extending radially therefrom and arranged in aligned pairs, a skewed roller 116 being mounted in the outer end of each arm. With this construction, the arms 115 employed are selected in view of the diameter of the tube to be cleaned and, for cleaning a tube of different diameter, the arms previously used are removed and others of different length are attached to the motor casing. With this construction, as with those above described, the skewing of the rollers insures that the counter-torque will be utilized to cause the cleaner to advance through the tube as the cleaning proceeds. Also the motor will be substantially centralized, although it may be slightly off axis in the event of variations in the internal diameter of the tube.

We claim:

1. In tube cleaning apparatus, the combination of a motor insertable endwise into the tube to be cleaned, the motor including a casing and a rotor and developing a counter-torque in operation tending to rotate the casing on an axis lengthwise of the tube, and means for supporting the motor including a plurality of members mounted on the casing and angularly spaced about the casing and rollers carried by the members and engageable with the inner surface of the tube, the rollers being skewed relative to the tube axis.

2. In tube cleaning apparatus, the combination of a motor insertable endwise into the tube to be cleaned, the motor including a casing and a rotor and developing a counter-torque in operation tending to rotate the casing on an axis lengthwise of the tube, and means for supporting the motor including a plurality of members mounted on the casing for movement toward and away from the tube and angularly spaced about the casing and rollers carried by the members and engageable with the inner surface of the tube, the rollers being skewed relative to the tube axis.

3. In tube cleaning apparatus, the combination of a motor insertable endwise into the tube to be cleaned, the motor including a casing and a rotor and developing a counter-torque in operation tending to rotate the casing on an axis lengthwise of the tube, and means for supporting the motor including a plurality of members mounted on the casing for movement toward and away from the tube and angularly spaced about the casing, connections between the members causing them to move in unison, means for moving the members, and rollers carried by the members and engageable with the inner surface of the tube, the rollers being skewed relative to the tube axis.

4. In tube cleaning apparatus, the combination of a motor insertable endwise into the tube to be cleaned, the motor including a casing and a rotor and developing a counter-torque in operation tending to rotate the casing on an axis lengthwise of the tube, and means for supporting the motor including a plurality of members mounted on the casing to swing toward and away

from the tube and angularly spaced about the casing, and rollers carried by the members and engageable with the inner surface of the tube, the rollers being skewed relative to the tube axis.

5. In tube cleaning apparatus, the combination of a motor insertable endwise into the tube to be cleaned, the motor including a casing and a rotor and developing a counter-torque in operation tending to rotate the casing on an axis lengthwise of the tube, and means for supporting the motor including a plurality of members mounted on the casing to swing toward and away from the tube and angularly spaced about the casing, connections between the members causing them to swing in unison, and rollers carried by the members and engageable with the inner surface of the tube, the rollers being skewed relative to the tube axis.

6. In tube cleaning apparatus, the combination of a fluid driven motor insertable endwise into the tube to be cleaned and including a casing and a rotor within the casing, the motor developing a counter-torque in operation tending to rotate the casing on an axis lengthwise of the tube, a plurality of members mounted on the casing to swing toward and away from the tube and angularly spaced about the casing, a sleeve mounted in the casing and connected to the members, means for admitting pressure fluid into the casing to drive the rotor, the sleeve being movable endwise to cause the members to swing in unison and being urged endwise by pressure fluid within the casing, and rollers carried by the members and engageable with the inner surface of the tube, the rollers being skewed relative to the tube axis.

7. In tube cleaning apparatus, the combination of a motor insertable endwise into the tube to be cleaned, the motor including a casing and a rotor and developing a counter-torque in operation tending to rotate the casing on an axis lengthwise of the tube, pairs of arms pivotally mounted on the casing, the arms of each pair lying aligned lengthwise of the casing and the pairs of arms being angularly spaced about the casing, a

U-shaped bar connecting the free ends of the arms of each pair and having its legs extending outwardly, a pair of rollers mounted on the legs of each bar in skewed relation to the axis of the casing, an annular element mounted on the casing for movement endwise thereof, and links connecting the element to one arm of each pair, whereby, on movement of the element, the arms swing in unison.

8. In tube cleaning apparatus, the combination of a fluid driven motor including a casing and a rotor, the motor being insertable endwise into the tube to be cleaned and developing a counter-torgue in operation tending to rotate the casing on an axis lengthwise of the tube, a sleeve mounted at one end of the casing, a swivel hose coupling connected to the sleeve for admission of pressure fluid through the sleeve into the interior of the casing, a plurality of members pivotally mounted on the casing and extending lengthwise thereof, the members being adapted to be swung toward and away from the tube, rollers carried by the members and engageable with the inner surface of the tube, the rollers being skewed relative to the axis of the tube, and connections between the sleeve and the members, the inner end of the sleeve being exposed to the fluid within the interior of the casing and the sleeve being movable under pressure of the fluid to move and swing the members toward the inner surface of the tube.

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