April 12, 1960 W. McCOLL 2,932,053

FLUID HEATER CLEANERS

Filed Nov. 4, 1955 3 Sheets-Sheet 1

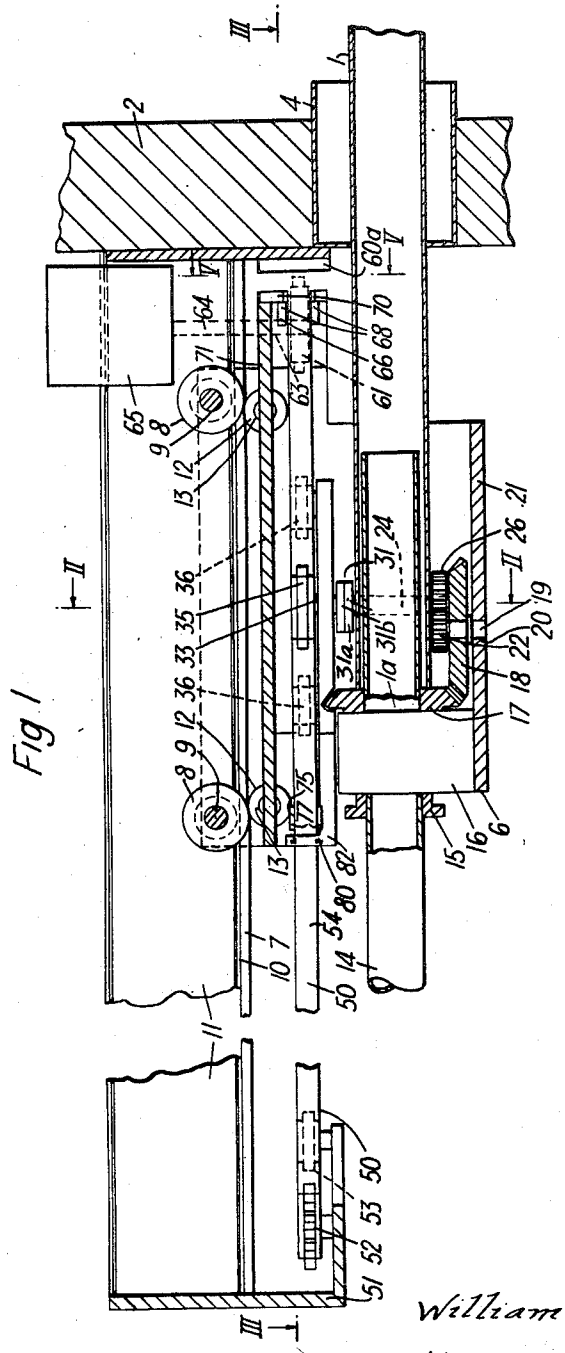


Fig 1

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April 12, 1960 W. McCOLL 2,932,053

FLUID HEATER CLEANERS

Filed Nov. 4, 1955 3 Sheets-Sheet 2

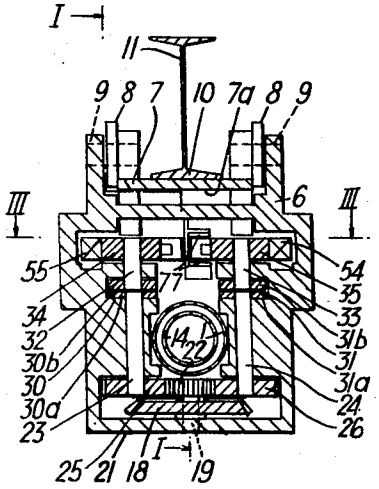


Fig. 2.

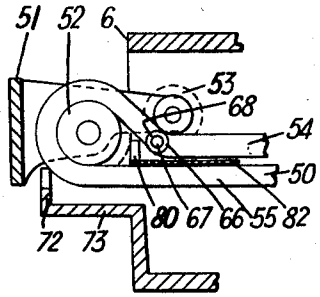


Fig. 4.

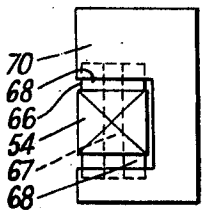


Fig. 5.

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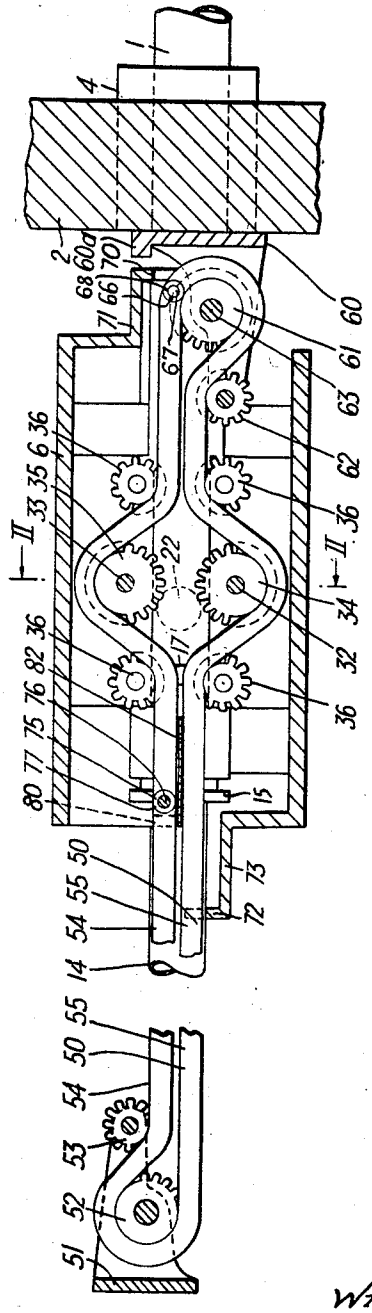
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FLUID HEATER CLEANERS

Filed Nov. 4, 1955 3 Sheets-Sheet 3

Fig 3



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2,932,053

FLUID HEATER CLEANERS

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Application November 4, 1955, Serial No. 544,942

Claims priority, application Great Britain November 4, 1954

11 Claims. (Cl. 15—317)

This invention relates to fluid heater cleaners. In large present day tubulous boilers difficult problems arise in maintaining the cleanliness of the outer surfaces of tubes which are arranged in banks of substantial depth and subjected to high gas temperatures. The invention is particularly concerned with a form of cleaner adapted for use in connection with such tube banks and having a nozzle tube axially reciprocable to advance the tube from a retracted position and to withdraw the tube to the retracted position and connected to a carriage movable to and fro along a track and operating mechanism for reciprocating the nozzle tube and carriage.

It has been proposed to effect the reciprocatory movement of the nozzle tube by means of a reversible motor coupled to an endless chain having a run which extends in a direction parallel to the nozzle tube and is coupled to the nozzle tube, whereby reversal of the direction of rotation of the motor effects reversal of the direction of reciprocation. When, as is usual, the cleaner constitutes one of a series of cleaners adapted to operate in sequence under the control of an automatic control system, the necessity of effecting reversal of the motor has resulted in complication of the control system. In this prior proposal, a separate driving motor was provided to obtain unidirectional rotation of the nozzle tube despite reversal of the direction of reciprocation.

An object of the present invention is the provision of means for effecting axial reciprocation of the nozzle tube and utilising a unidirectionally rotating motor. By the present invention a single motor may be utilised to provide both unidirectional rotation of the nozzle tube and reciprocation of the nozzle tube.

According to the present invention, in a fluid heater cleaner having a nozzle tube axially reciprocable to advance the tube from a retracted position and to withdraw the tube to the retracted position and connected to a carriage movable to and fro along a track and operating mechanism for reciprocating the nozzle tube and carriage, the operating mechanism includes endless flexible means having two runs extending longitudinally of the track and coupling means adapted when the endless flexible means is driven unidirectionally automatically to couple the carriage to one run for controlled movement of the carriage and nozzle tube in one direction and to the other run for controlled movement of the carriage and blower tube in the opposite direction.

The invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a partly broken away sectional side elevation of a fluid heater cleaner, taken on the line I—I of Figure 2 and as viewed in the direction indicated by the arrows; and shows a nozzle tube thereof in a position adjacent an extreme forward operating position;

Figure 2 is a sectional front elevation taken on the line II—II of Figure 1, as viewed in the direction indicated by the arrows;

Figure 3 is a sectional plan view taken on the line III—III of Figure 1;

Figure 4 is a sectional fragmentary plan view of parts of the cleaner shown in Figure 3, but with moving parts thereof shown in a rearward extreme operative position; and

Figure 5 is a front elevation of a driving abutment taken on the line V—V of Figure 1 and as viewed in the direction indicated by the arrows.

The cleaner illustrated includes a nozzle tube **1** which may be advanced through an aperture in a wall **2** of the casing of a tubulous fluid heater with which the cleaner is associated from a retracted position to an advanced position slightly forward of the position shown in Figure 1. A forward end of the nozzle tube (not shown) is provided with nozzle apertures one of which is arranged to project fluid at right angles to the axis of the nozzle tube and another of which is arranged to project fluid forwardly at an angle to the said axis, the nozzles being so arranged that in operation the forces acting transversely of the nozzle tube due to the discharges from the nozzles are substantially balanced. While the nozzle tube is in the retracted position, the forward end is surrounded by a wall box **4** which serves to shield the forward end of the tube.

The nozzle tube **1** is supported immediately outside the wall **2** upon a bracket (not shown) which is adapted to permit free rotation of the tube **1** and at its rearward end **1***a* is mounted in a carriage **6**. Carriage **6** is suspended from a track plate **7** by four flanged upper guide rollers **8** rotatably mounted upon pivot pins **9** secured to the carriage **6**. The track plate **7** is secured to and wider than the lower flange **10** of an I-beam **11**, which is mounted on and which extends normally outwardly from the wall **2** parallel to, above and beyond the retracted nozzle tube **1**. Four lower guide rollers **12** mounted upon pivot pins **13** secured to the carriage are disposed below the track plate **7** in engagement with its lower surface **7***a*.

The nozzle tube **1**, which is of substantial length, for example 25 feet long, is telescopically arranged with respect to a coaxial stationary tube **14** for the supply of cleaning fluid supplied under substantial pressure, the rear end **1***a* of the nozzle tube **1** being secured to a stuffing box member **15** arranged to make a pressure tight seal between the tubes **1** and **14**. The rearward end of the supply tube **14** is connected to a valve chest (not shown) which may be of the form shown in the specification of British Patent No. 636,052.

The actual mounting for the nozzle tube **1** in the carriage **6** is not detailed in the drawings, but takes the form of a journal and thrust bearing **16** which engages the outside surface of the stuffing box member **15** to permit the latter to rotate relatively to the carriage about the axis of the tube **1** and to inhibit axial movement of the member **15** and thus the tube **1** through the carriage.

The forward end of the stuffing box member **15** is formed as a bevel gear wheel **17** which coacts with a second bevel gear wheel **18** formed with an axle **19** fitted into a bearing **20** in floor **21** of the carriage **6** and formed on its upper side with a spur gear wheel **22**. Also mounted in the carriage are two vertical shafts **23** and **24** disposed forwardly of the bearing **20** and one on either side of the spur gear wheel **22**. Spur gear wheels **25** and **26** respectively mounted on the two shafts **23** and **24** are arranged operatively to engage the gear wheel **22** and the two shafts respectively carry at their upper ends the driven parts **30***a* and **31***a* of two free-wheel devices **30** and **31**. The driving parts **30***b* and **31***b* of the two devices **30** and **31** are mounted on the lower ends of two vertical shafts **32** and **33** rotatably mounted in the car-

riage 6 and respectively provided at their upper ends with actuating wheel chain sprockets 34 and 35 keyed to the shafts. Also mounted on the carriage 6 are four chain sprocket jockey pulley wheels 36, the six chain sprockets all being arranged with their teeth in the same horizontal plane.

The free-wheel devices 30 and 31 are both of the same "hand," such that when one of the chain sprockets 34 and 35 is rotated in a clockwise direction (as viewed from above) the intermediate bevel gear wheel 18 rotates in a counterclockwise direction causing the nozzle tube 1 to rotate in a clockwise direction, as viewed in Figure 2. This rotation is quite independent of whether the second of the chain sprockets 34 and 35 is caused to rotate in either direction or is held against rotation.

Endless flexible means in the form of an endless chain 50 are arranged to extend horizontally along and below the track plate 7 and through the upper part of the carriage 6, the chain being disposed on the outward sides of the two sprockets 34 and 35 and on the inward sides of the four jockey wheels 36, as is shown most clearly in Figure 3. At the rear end of the track plate 7 a bracket 51 is secured to the I-beam 11 and supports a rotatably mounted idler chain sprocket wheel 52 and a rotatably mounted chain sprocket jockey pulley wheel 53, the sprockets 52 and 53 being arranged with their teeth in the same horizontal plane as are the teeth of the sprockets 34, 35 and 36. The chain 50 is so lapped about the sprockets 52 and 53 that the advancing run 54 and the returning run 55 of the chain are closely spaced together, as shown in Figure 3.

At the forward end of the track plate 7 a bracket 60 is secured to the I-beam 11 and supports a driving sprocket wheel 61 and a chain sprocket pulley wheel 62 arranged with their teeth in the same plane as the teeth of the two sprockets 52 and 53. The driving sprocket wheel 61 is fixedly mounted upon a driving shaft 63 coupled to the output shaft 64 of a combined electric motor and gear box unit 65 which is suitably mounted on the I-beam above the sprocket 61. The centres of the driving sprocket wheel 61 and the idler sprocket wheel 52 are respectively off-set on opposite sides of the centre line of the track, the jockey wheels 53, 62 being on opposite sides of the two runs of the chain.

Bracket 60 is formed with a projection 60*a* adapted to engage the carriage 6 and so limit forward movement of the carriage in a positive manner.

The chain 50 is a roller chain comprising links having side plates connected by pivot pins that serve to couple adjacent links together in a hinged manner, the pins being provided with rotatable rollers. One of the chain links is provided with a driving device 66 including a pivot pin 67 that extends at each end laterally of the chain beyond the associated side plates a distance equal to about one third of the length of the standard pivot pins and a roller 68 carried upon each end of the pin

The carriage is provided with two driving abutments adapted for engagement by the driving device 66, a forward driving abutment 70 provided on a forward projection 71 of the carriage 6 and a rearward driving abutment 72 provided on a rearward projection 73 of the carriage 6. Each driving abutment 70 and 72 is in the form of a fork which embraces the outer side and top and bottom faces of the associated advancing run 54 or returning run 55 of the chain, and the bifurcations of which are arranged respectively to engage the two rollers 68, as shown for the forward driving abutments 70 and advancing run 54 in Figure 5. It will be seen in that figure that there is a considerable clearance above and below the chain, but this clearance is much less than the height of the rollers 68.

The chain 50 is also provided with a braking device 75 similar to the driving device 66 and comprising a pivot pin 76 and two rollers 77 mounted upon the pin, the rollers 77 being of much smaller width than the rollers 68 and the whole braking device being of such size that it can pass through the forked driving abutments 70 and 72.

The carriage 6 is provided adjacent its rearward end with a braking abutment 80 in the form of a fork arranged with its bifurcations extending respectively above and below the advancing run 54 of the chain 50 from a plate 82 mounted on the carriage 6 and extending downwardly from the top of the carriage between the two runs 54 and 55 of the chain. Unlike the two driving abutments, this abutment 80 embraces the chain closely so that the rollers 77 of the braking device 75 may effectively engage the braking abutment.

The carriage 6 is provided with a rearwardly extending arm (not shown) arranged to actuate a stop valve that controls the supply of cleaning fluid to the rear end of stationary tube 14; during rearward movement of the carriage the arm actuates the stop valve to discontinue the supply of cleaning fluid before the nozzle tube reaches its rearward, fully retracted, position. Such an arrangement is described and illustrated in the specification of British Patent No. 636,052.

A limit switch (not detailed) is mounted on the track plate 7 where it will be engaged by the driving device 66 as it approaches the position shown in Figure 4, and the indication given by engagement of the driving device with the limit switch is supplied to a suitable control system which will determine whether motor unit 65 is to remain energised or to become de-energised. The rotational inertia of the motor unit will cause the driving device 66 to disengage from the limit switch before the chain comes to rest.

During periods when the fluid heater cleaner is not in use, the nozzle tube is in a fully retracted position in which the forward end of the nozzle tube lies within the wall box 4 and the rearward end of the carriage lies in the position indicated in Figure 4. The stop valve controlling the supply of cleaning fluid is closed and the driving device 66 lies in the position shown in Figure 4 or in some nearby position in the advancing run 54 of the chain 50.

To initiate operation of the cleaner, electrical power is supplied to the electric motor unit 65, which commences to rotate and moves the chain 50 in a clockwise direction as seen from above. At first the carriage 6 will remain stationary and the only effect of the movement of the chain will be to cause rotation of the actuating wheel sprockets 34 and 35. Since sprocket 34 is caused to rotate in a clockwise direction, it will be effective through the free-wheel device 30 to cause rotation of the bevel gear wheel 18 in a counterclockwise direction and to cause the bevel gear wheel 17 and the nozzle tube 1 to rotate in a clockwise direction, as viewed in Figure 2. The actuating wheel sprocket 35 rotates also in a clockwise direction and through the associated free-wheel device 31 assists in the driving of bevel gear wheel 18.

As the chain 50 rotates, the driving device 66 moves from the position shown in Figure 4 forwardly with the advancing run 54 through the carriage 6 until it engages the forward driving abutment 70, whereupon the carriage moves forward with, and at the same speed as, the chain 50. Immediately before the carriage is thus coupled to the chain, the braking device 75 passes round the jockey sprocket 53 and assumes a position relative to the carriage immediately in front of the braking abutment 80 i.e. as shown in Figure 3.

Since the carriage is now moving forwardly at the speed of the chain 50, its velocity relative to the returning run 55 of the chain is now doubled, and as a direct result the speed of rotation of the nozzle tube 1 by the actuating wheel 34 and free-wheel device 30 is also doubled. Actuating wheel 35 during this movement is uncoupled from the nozzle tube 1 by action of the free-wheel device 31.

After a predetermined forward travel of the carriage 6, opening of the stop valve which controls the supply of cleaning fluid is effected by the stop valve actuating arm, referred to above, mounted upon the moving carriage, and cleaning fluid under substantial pressure is admitted to the interior of the nozzle tube 1 and is discharged through the nozzles provided at and near the forward end thereof.

Once this pressure is applied to the interior of the nozzle tube 1 the nozzle tube is biased forwardly with the carriage relative to the fixed tube 14 by the unbalanced pressure acting upon the forward end of the nozzle tube, and the subsequent action of the chain during the remainder of the forward movement of the nozzle tube 1 depends upon whether this biasing force is greater than or less than the frictional forces which act on the nozzle tube and tend to retard its forward movement relative to the tube 14. For example, a given fluid heater cleaner may, due to wear of the packing in the stuffing box member 15 and due to the accumulation of deposits on the outer extremities of the nozzle tube 1 and the fouling of such deposits with supporting bearings provided on the tubes of the fluid heater, at different times in its working life behave in different ways.

If the pressure inside the nozzle tube 1 is insufficient to cause the nozzle tube to advance along the tube 14, then controlled forward movement of the nozzle tube will be effected by engagement of the driving device 66 with the forward driving abutment 70 until the driving device passes round the driving sprocket wheel 61 and so moves sidewardly out of engagement with the abutment 70.

If the pressure inside the nozzle tube 1 is sufficient to cause the nozzle tube to advance along the tube 14, after a very short relative movement the braking abutment 80 comes into contact with braking device 75. The braking device 75 is then effective to cause controlled forward movement of the carriage and blower tube until the projection 60*a* of bracket 60 engages the forward projection 71 of the carriage 6 in order to terminate forward movement of the carriage at a position a short distance beyond that position at which the driving device 66 disengages the driving abutment 70. Continued forward movement of the chain will then cause the braking device to become disengaged from the braking abutment 80.

Upon termination of the forward movement of the carriage 6 and the nozzle tube, the movement of the chain 50 is still effective to cause rotation of the nozzle tube 1, but since the carriage is now at rest, the speed of rotation of the nozzle tube is reduced to half the speed of rotation obtained during forward movement of the nozzle tube.

The driving device 66 enters the returning run 55 of the chain and after a short delay engages the rearward driving abutment 72 to couple the carriage 6 to the returning run of the chain and so effect rearward movement of the carriage and nozzle tube. During this delay period, the braking device reaches and passes freely through the forward driving abutment 70 and also passes round the driving wheel 61.

During rearward movement of the carriage, it is at rest relative to the returning run 55 and as a result its velocity relative to the advancing run 54 of the chain is doubled, so that the speed of rotation, effected by the chain through the actuating wheel 35 and the free-wheel device 31, of the blower tube 1 is doubled. In the arrangement shown, in which the chain sprockets 34 and 35 have equal numbers of teeth, the speeds of rotation of the nozzle tube during forward and rearward movement are equal to one another and are equal to twice the speed of rotation which obtains during the dwell of the nozzle tube while in the forward position, but if these sprockets had unequal numbers of teeth, the speed of rotation during the forward travel would be different from the speed of rotation during the rearward travel.

As the carriage approaches the rearward position indicated in Figure 4, the stop valve is operated by the arm on the carriage to stop the supply of cleaning fluid to the nozzle tube. At the rearward position of the carriage, the driving device 66 passes round the idler wheel 52 and so disengages from the rearward driving abutment 72. As will be clear from Figure 4, the braking abutment is so set in relation to the rearward driving abutment that the devices are able to pass round the jockey wheel 53 without engagement with the braking abutment.

The limit switch is actuated by the driving device 66 as it approaches the position shown in Figure 4 and the associated control system will determine whether the cleaning operation is to continue or to terminate. If the electric motor unit 65 is allowed to remain energised by the control system, the cycle of operations will be repeated, and the nozzle tube 1 will re-enter the fluid heater, pause in the forward position, and be retracted.

If desired, the period of the forward dwell may be reduced or substantially eliminated by the provision of a plurality of driving devices so arranged that movement of one driving device away from the forward driving abutment is followed in quick succession by engagement of a second driving device with the rearward driving abutment, the second driving device being positioned on the chain a short distance in advance of the first driving device and being so dimensioned that it is able to pass the forward driving abutment. Thus the second driving device may extend laterally of the chain to a smaller extent than the first driving device, the fork of the forward driving abutment being designed to permit passage of the second driving device but to prevent passage of the first driving device, whilst the fork of the rearward driving abutment is designed to prevent passage of the second driving device. With the arrangement described, when at the end of the advancement of the nozzle tube the first driving device moves sidewardly to disengage from the forward driving abutment, the second driving device is already in the returning run of the chain and quickly engages the rearward driving abutment so that the carriage is driven rearwardly.

The constructions of fluid heater cleaner described above have several advantageous features. Thus, since the motor for effecting actuation of the nozzle tube is a fixture adjacent the wall of the fluid heater it is no longer necessary to provide a gallery for affording ready access to working parts which extend over the total length of the track plate and the need for a flexible trailing power lead to a motor mounted on and moving with the carriage is eliminated. Although only a single driving motor is provided, reciprocating movement of the nozzle tube is accompanied by unidirectional rotation of the nozzle tube. As a result, during withdrawal, the jets of cleaning fluid sweep over a helical path which is a different path from the helical path swept during the advancement of the nozzle tube. Since the cleaning action is effective both during the advancement and during the retraction of the nozzle tube, a substantial saving of cleaning fluid may be obtained. The jockey pulleys 36 serve to cause each run of the chain to embrace a suitable arc of the associated actuating wheel and maintain proper lateral positioning of the associated run to the forward and rearward sides of the actuating wheel relatively to the carriage and the abutments thereon. Furthermore, the driving abutments may be arranged to give a desired dwell period of the nozzle tube in its forward position in order that tubes of the fluid heater beyond the end of the nozzle tube may be effectively cleaned.

The braking device may be omitted and the driving device serve also as a braking device which engages the braking abutment to limit uncontrolled forward movement, but the preferred construction described has the advantage that appreciable unchecked movement of the nozzle tube under the influence of the cleaning fluid pressure is avoided.

I claim:

1. In a fluid heater cleaner having a nozzle tube axially reciprocable to advance the tube from a retracted position and to withdraw the tube to the retracted position and connected to a carriage movable to and fro along a track and operating mechanism for reciprocably driving the nozzle tube and carriage substantially horizontally in both directions, wherein the operating mechanism includes endless flexible means having two runs extending longitudinally of the track, unidirectional driving means for actuating said flexible means, coupling means adapted when the endless flexible means is driven unidirectionally automatically to couple the carriage to an advancing one of said runs for controlled advancing movement of the carriage and nozzle tube and to the other run, which constitutes a return run, for controlled return movement of the carriage and nozzle tube, the endless flexible means being substantially inelastic, said coupling means comprising first abutment means provided on the carriage, a driving element projecting laterally from the flexible means and arranged to engage the first abutment means in the advancing run of the chain, said driving element being arranged to disengage from the first abutment means at or after the end of the advancing movement and to travel around a wheel at the end of the said run, and second abutment means provided on the carriage spaced longitudinally and rearwardly of the first abutment means to provide a dwell period for the nozzle tube in its extreme positions, said second abutment means being arranged to be engaged by said driving element in the return run of the flexible means, the driving element being arranged to disengage from the second abutment means during movement around a further wheel at the end of the return run.

2. In a fluid heater cleaner as claimed in claim 1, a braking abutment on the carriage spaced between said first and second abutment means, and coacting braking abutment means on the flexible means, for the retardation of forward movement of the nozzle tube during periods when the nozzle tube is to be moved forwardly and is biased forwardly by the pressure of cleaning fluid supplied to its interior, and means for diverting said coacting braking abutment means on the flexible means and said driving element around said braking abutment on the carriage during their movements in the area of said further wheel.

3. A fluid heater cleaner as claimed in claim 2, wherein said coacting abutment means on the flexible means projects laterally from the flexible means and is so spaced upon the flexible means from the driving element that advancing movement of the carriage at a speed exceeding that of the flexible element which results in disengagement of the driving element from the first abutment means is followed in quick succession by engagement of the braking abutment with the coacting braking abutment means on the flexible means, the coacting braking abutment means on the flexible means being so dimensioned that it is able to pass the first and second abutment means on the carriage.

4. A fluid heater cleaner as claimed in claim 3, wherein the driving element and said braking abutment means on the flexible element each comprise extensions fixed to and projecting from the flexible means, and each abutment means on the carriage includes a fork having bifurcations for engagement with respective extensions.

5. A fluid heater cleaner as claimed in claim 1, wherein one of said wheels is a driving wheel and the other of said wheels is an idler wheel spaced from the driving wheel along the track, jockey wheels arranged respectively adjacent the driving wheel and the idler wheel and engaging the endless flexible means to cause the two runs to lie closely adjacent one another, and the carriage is provided with locating means adapted to engage the runs and maintain proper lateral positioning thereof relatively to the abutment means.

6. A fluid heater cleaner as claimed in claim 5, including means at one end of the track for mounting said end of the track against a fluid heater with the rest of the track projecting therefrom, the driving wheel being disposed at or adjacent said end of the track.

7. A fluid heater cleaner having a nozzle tube axially reciprocable to advance the tube from a retracted position and to withdraw the tube to the retracted position and connected to a carriage movable to and fro along a track and operating mechanism for reciprocating the nozzle tube and carriage, wherein the operating mechanism includes endless flexible means having two runs extending longitudinally of the track, unidirectional driving means for actuating said flexible means, and coupling means adapted when the endless flexible means is driven unidirectionally automatically to couple the carriage to one run for controlled movement of the carriage and nozzle tube in one direction and to the other run for controlled movement of the carriage and nozzle tube in the opposite direction, and wherein the endless flexible means drives power transmission means on the carriage to rotate the nozzle tube, said tube during retraction being rotated in the same sense as during advancement so that during the retraction the discharge of cleaning fluid sweeps through a helical path different from that over which the discharge sweeps during the advancement.

8. A fluid heater cleaner as claimed in claim 7, wherein the runs of the endless flexible means are coupled with respective actuating wheels on the carriage and the actuating wheels are coupled with the nozzle tube for rotation thereof through means permitting each wheel to be driven through relative movement between the run associated therewith and the carriage while the other actuating wheel is stationary about its axis.

9. A fluid heater cleaner as claimed in claim 8, wherein each actuating wheel is coupled to the nozzle tube through a free-wheel device and a gear wheel to a common gear wheel.

10. A fluid heater cleaner as claimed in claim 9, the common gear wheel being coupled with the nozzle tube through an intermediate bevel wheel and a bevel wheel coaxial with the nozzle tube.

11. A fluid heater cleaner as claimed in claim 8, wherein associated with each actuating wheel are two jockey pulleys which serve to cause the endless flexible means to embrace a suitable arc of the actuating wheel and maintain proper lateral positioning of the associated run at opposite sides of the actuating wheel relatively to the carriage.

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