United States Patent [19]

Marriott et al.

[11] **3,804,256**

[45] **Apr. 16, 1974**

[54] **MAGNETIC SEPARATOR WITH IMPROVED SQUEEGEE ROLLER**

[75] Inventors: **Roger Marriott; Mark R. Estabrook,** both of Rockford, Ill.

[73] Assignee: **Barnes Drill Co.,** Rockford, Ill.

[22] Filed: **Aug. 14, 1972**

[21] Appl. No.: **280,664**

[52] **U.S. Cl.** **210/222,** 209/232, 210/386

[51] **Int. Cl.** **B01d 35/06,** B01d 33/02

[58] **Field of Search** 210/222, 223, 107, 351, 210/402, 386; 209/232

[56] **References Cited**

UNITED STATES PATENTS

2,564,515	8/1951	Vogel	210/222 X
3,522,883	8/1970	Steckhan	210/402 X
3,017,031	1/1962	Lowler	210/222
3,346,116	10/1967	Jones	210/222
3,360,126	12/1967	Watts et al.	209/232
3,439,808	4/1969	Sommermeyer	209/232
2,088,364	7/1937	Ellis et al.	209/232
3,487,939	1/1970	Keeley	210/222

Primary Examiner—Samih N. Zaharna
Assistant Examiner—T. A. Granger
Attorney, Agent, or Firm—Wolfe, Hubbard, Leydig, Voit & Osann, Ltd.

[57] **ABSTRACT**

A squeegee roller for the rotatable drum of a magnetic separator comprises a plurality of segments each mounted on a common shaft for engagement with the surface of the drum to squeeze liquid from the swarf picked up by the drum. The diameter of the roller shaft is smaller than the diameter of the openings in the roller segments to allow the shaft to move a predetermined distance within the segments before lifting the segments from the surface of the drum. Normally, the shaft is spring biased to hold the segments tightly against the surface of the drum. As the drum rotates, a follower thereon engages a cam to overcome the spring and lift the shaft a predetermined distance within the openings. Because of a magnetic core, the segments are held against the surface of the drum by the magnetic force of the drum and thereby squeeze the coolant from the swarf while at the same time riding over the top of piles of swarf accumulated in front of the segments to allow the piles to be carried past the segments for scraping from the drum.

8 Claims, 9 Drawing Figures

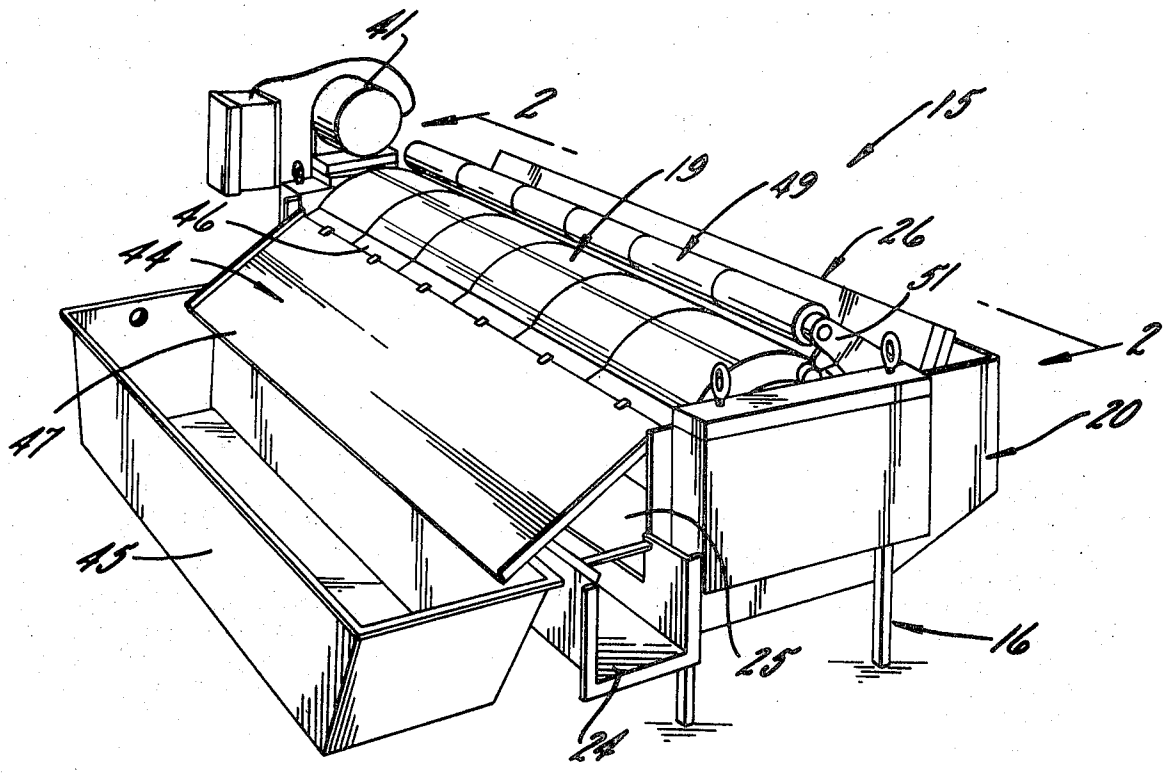


Fig. 1

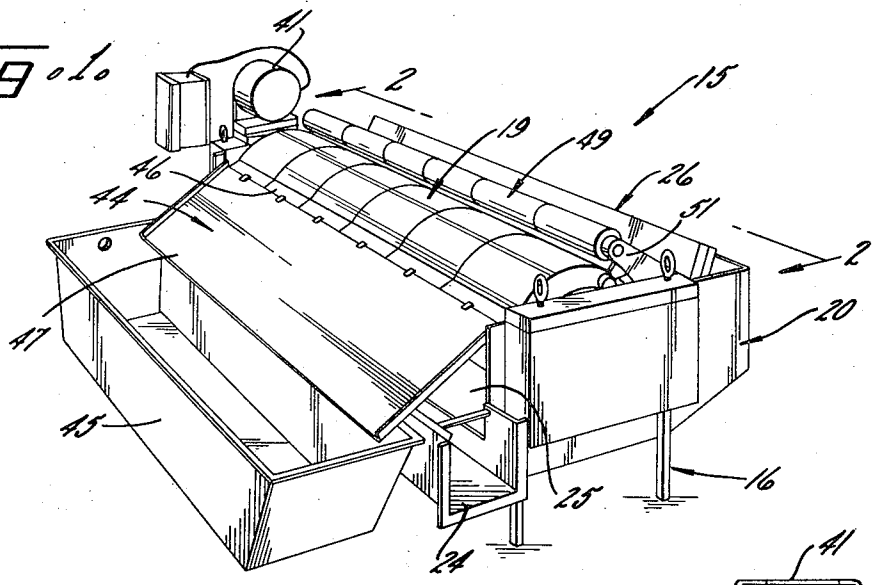


Fig. 2

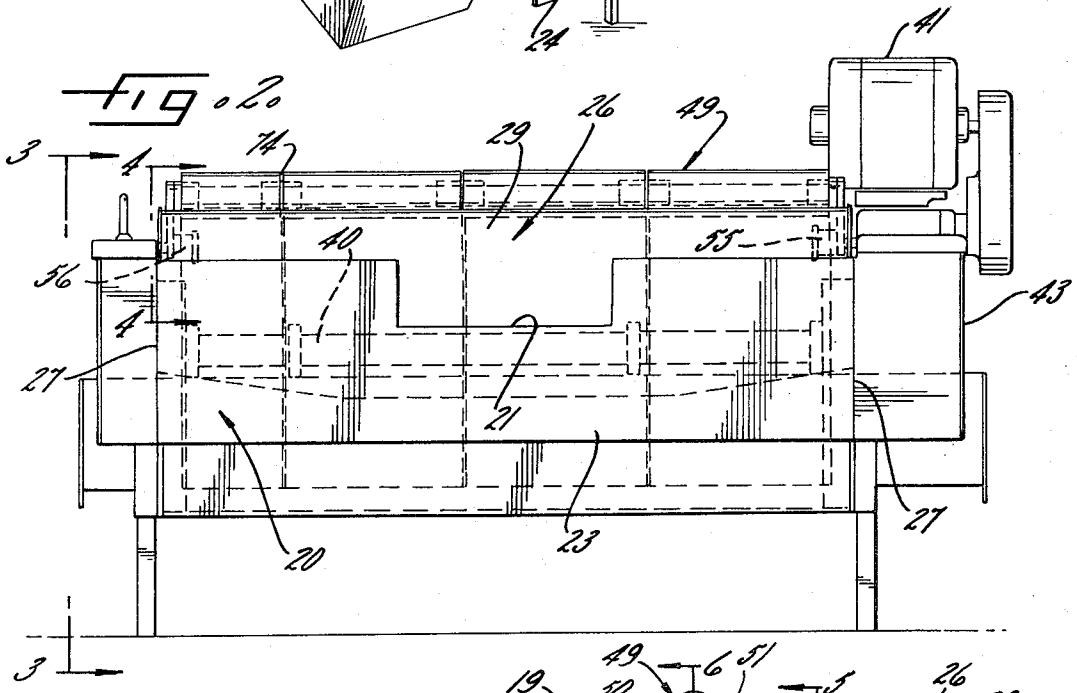


Fig. 3

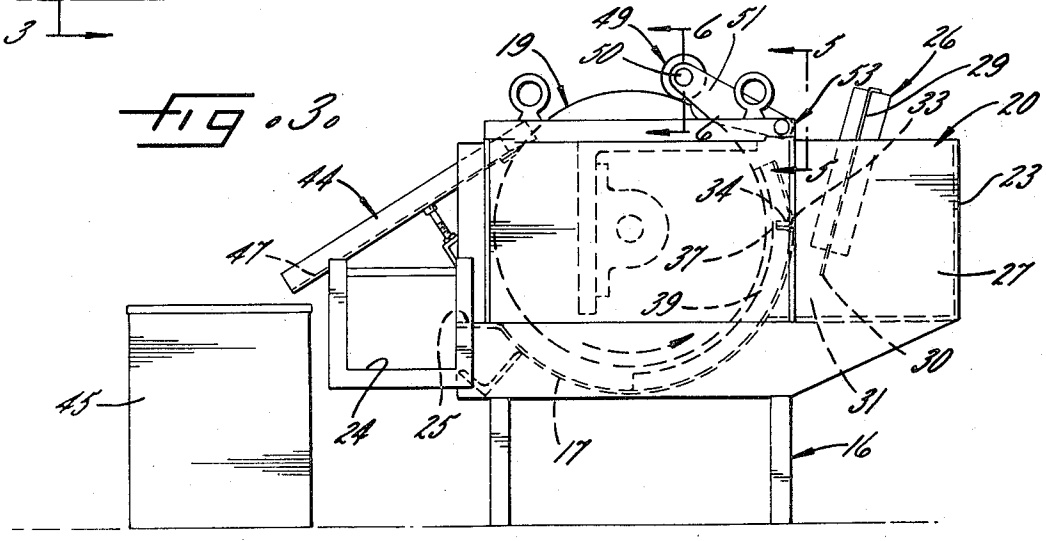


Fig. 4.

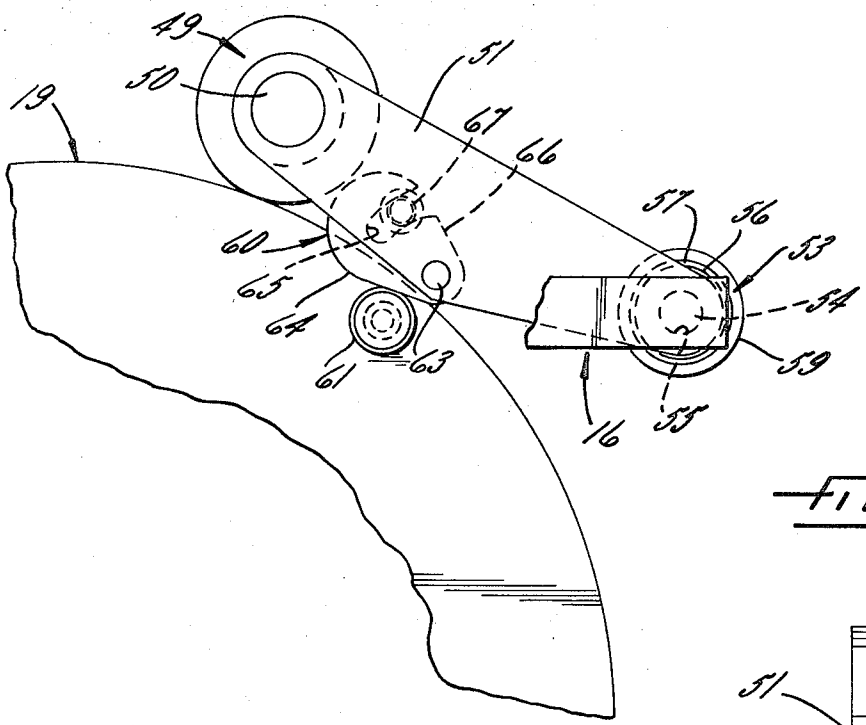


Fig. 5.

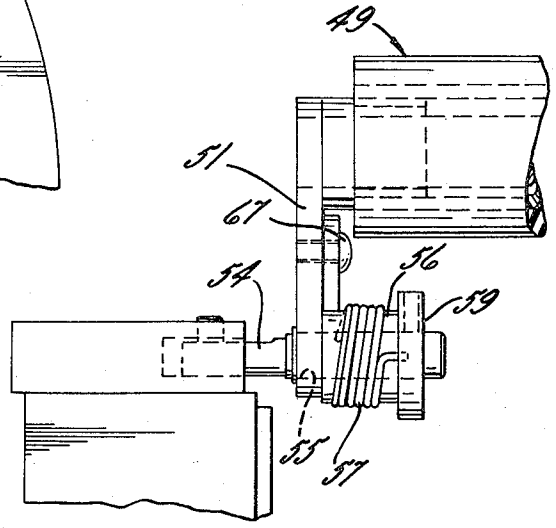


Fig. 6.

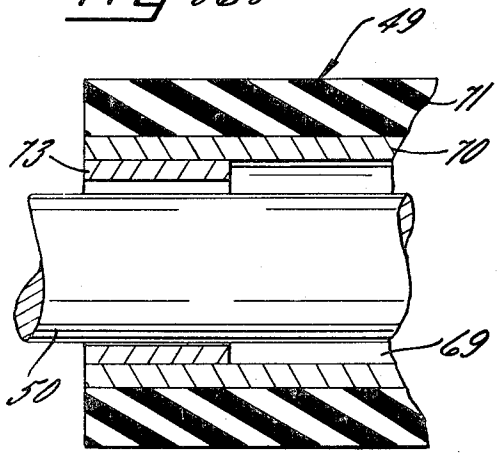


Fig. 7.

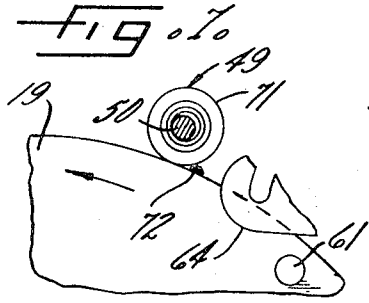


Fig. 8.

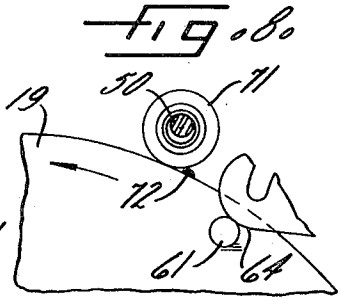
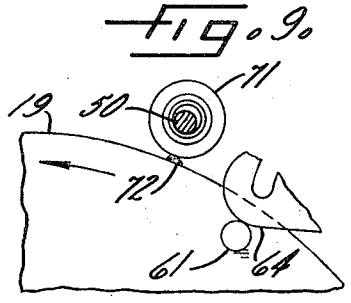


Fig. 9.



MAGNETIC SEPARATOR WITH IMPROVED SQUEEGEE ROLLER

BACKGROUND OF THE INVENTION

This invention relates to a magnetic separator of the type used to clean a liquid coolant by magnetically removing entrained metal chips and fine particles, commonly called swarf, from the coolant. More particularly, the invention relates to a magnetic separator of the type in which the liquid coolant is washed past the magnetized surface of a drum to collect the swarf from the coolant. A roller mounted on the separator in engagement with the top of the drum serves to squeeze the coolant off the surface of the drum to prevent the coolant from being carried over and dumped into a sludge tank with the swarf. Normally during squeezing, the roller rolls over the collected swarf and presses coolant therefrom to flow back over the surface of the drum toward the uncleaned coolant.

SUMMARY OF THE INVENTION

The primary object of the present invention is to provide a new and improved magnetic separator of the above general character which eliminates the likelihood of the swarf piling up and wedging underneath the front of the roller and causing the roller to jam and stop turning. More particularly, it is the object of this present invention to accomplish the foregoing without a substantial amount of coolant being lost such as by being carried over with the piles of swarf which pass beneath the roller to be scraped off the drum and into the sludge tank.

A more detailed object is to decrease the pressure holding the roller against the surface of the drum momentarily in such a manner as to allow built-up piles of swarf to pass under the roller to move toward the sludge tank while at the same time avoiding the loss of all the squeezing action of the roller.

The invention also resides in the unique construction of the roller and the manner in which the roller is mounted on the separator to take advantage of the magnetic attraction of the drum to hold the roller yieldably against the drum surface to roll over built-up swarf and the provision of a roller comprising a plurality of segments each separately movable so that the entire roller need not be lifted off the surface of the drum to roll over a pile of swarf.

These and other objects and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a magnetic separator embodying the novel features of the present invention.

FIG. 2 is an enlarged elevational view taken along line 2—2 of FIG. 1.

FIG. 3 is an elevational view taken along line 3—3 of FIG. 2.

FIG. 4 is an enlarged fragmentary view taken substantially along line 4—4 of FIG. 2.

FIG. 5 is an enlarged fragmentary view taken substantially along line 5—5 of FIG. 3.

FIG. 6 is an enlarged cross-sectional view taken substantially along line 6—6 of FIG. 3.

FIGS. 7 through 9 are schematic elevational views showing successive moved positions of parts during the operation of the separator.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawings for purposes of illustration, the present invention is embodied in a magnetic separator 15 commonly used to cleanse a liquid coolant, such as is used in machining operations, of magnetic particles or swarf so that the coolant can be reused. Herein, the separator comprises a frame 16 supporting a tub 17 (FIG. 3) within which a drum 19 is rotatably mounted on the frame. The surface of the drum is magnetized by a plurality of permanent magnets (not shown) to pick up swarf from the coolant as the latter is washed across the surface of the drum. As shown in FIG. 2, the coolant is received within a tank 20 mounted on the frame at the front of the tub and enters the tank through an inlet 21 formed in the front wall 23. A discharge trough 24 (see FIG. 1) is attached to the frame at the back of the tub to receive the cleaned coolant from an outlet 25 in the backwall of the tub.

In use, the coolant flows into the tank 20 through the inlet 21 and impinges against a generally rectangular baffle 26 so that the flow of coolant is spread evenly along the length of the drum 19. As shown in FIGS. 2 and 3, the baffle spans the length of the tank and is positioned edgewise in a generally vertical direction between the sides 27 of the tank so that the broadside 29 of the baffle faces the incoming flow of coolant. More particularly, the baffle is inclined slightly forward from its bottom edge 30 to direct the coolant impinging against the broadside downwardly and outwardly toward the sides of the tank. With this arrangement, the lower edge of the baffle and the bottom wall of the tank define a flow way 31 (FIG. 3) admitting the coolant to pass toward the rear of the tank and into the tub 17.

An outlet 33 of the tank is spaced above the bottom edge 30 of the baffle 26 and is defined by a weir 34 (FIG. 3) adjustable rearwardly toward the surface of the drum 19 to select the size of an opening 37 leading into a passage 39 between the drum and the tub. By virtue of this arrangement, a substantial portion of the coolant flowing over the weir washes across the surface of the drum so that the swarf passes close by the surface of the drum to be picked up by the magnets. Upon passing the end of the weir, the coolant drops into the narrow passage 39 which is defined by the surface of the drum and the curved bottom wall of the tub and washes across the magnetic surface of the drum so to further collect the entrained swarf on the surface of the drum.

The drum 19 is fixed on a shaft 40 (FIG. 2) journaled on the frame 16 at opposite ends of the tub 17 and power rotated by a motor 41 through a speed reducer 43. Both the motor and the speed reducer are mounted at one end of the tub on the frame, the speed reducer being power connected to the motor and receiving one end of the shaft to drive the latter. More particularly, the shaft is rotated so that the bottom of the drum moves in a direction counter to the flow of coolant (as viewed in FIG. 3 counterclockwise). Thus, as the swarf accumulates on the surface of the drum, it is carried upwardly and out of the tub as the cleaned coolant continues to flow through the passage 39 to exit through

the outlet 25 at the back of the tub and into the discharge trough 24.

Mounted on the frame 16 above the trough 24 is a scraper 44 (FIG. 1) which serves to remove the swarf collected on the surface of the drum and to deposit the collected swarf into a sludge tank 45 located behind the separator 15 along the trough. In the exemplary embodiment, the scraper includes an elongated blade 46 attached to a chute 47 which extends rearwardly above the trough and leads to the sludge tank so that, as the swarf is scraped from the surface of the drum, it slides down the chute and is collected in the sludge tank.

While in the present instance the major portion of the coolant flows past the drum 19 and is cleaned, some coolant is carried on the surface of the drum with the swarf and is carried out of the tub 17 by the rotating drum. To avoid losing this coolant by its being carried with the swarf over into the sludge tank 45, the coolant is squeezed from the surface of the drum to flow back into the tub with the rest of the clean coolant. This is accomplished through the use of a squeegee roller 49 which rolls over the swarf squeezing the coolant from the swarf and across the surface of the drum while the swarf passes on toward the scraper 44.

The roller 49 is mounted on the frame 16 to engage the surface of the drum 19 forwardly of the extreme top of the drum so that the coolant squeezed from the swarf flows back toward the opening 37 of the passage 39, Because a relatively high pressure is required to squeeze the coolant along the surface of the drum, the swarf tends to build up in front of the roller and slide across the surface of the drum as the latter rotates. With a sufficient build up, the swarf may wedge between the roller and the drum and stall the roller thereby preventing it from turning and performing its intended function.

In accordance with the primary aspect of the present invention, the roller 49 is mounted on the separator 15 in a unique manner so as to avoid the buildup of swarf and at the same time squeeze the coolant across the surface of the drum 19 to flow back into the tub 17. For this purpose, the roller is mounted in a fashion such that momentarily as the drum rotates the roller is capable of rolling up and over a pile of swarf without a substantial loss in the squeezing action of the roller. Thus, the amount of coolant carried past the roller is kept to negligible volume and the roller is kept from stalling due to the wedging of the swarf under the front of the roller.

In the present instance, the roller 49 is telescoped over an elongated shaft 50 (FIG. 3) extending along the surface of and generally parallel with the rotational axis of the drum 19. The opposite ends of the shaft are secured to the free ends of two arms 51 which are mounted by their opposite ends 53 on the frame 16 adjacent the ends of the drum. As shown in FIGS. 4 and 5, each of the arms is supported on the frame by a rod 54, the latter being telescoped through a hole 55 in the end 53 of the arm and a collar 56 fixed on the arm around the hole. Moreover, each arm is pivotable on its rod and biased by a spring 57 generally toward the drum in a counterclockwise direction as viewed in FIG. 4 to urge the roller against the drum. Each spring is coiled around its associated collar and has one end secured thereto and the other end secured to a flange 59 fixed on the free end of the rod. Thus, the two arms with their associated springs coact to bias the shaft 50 toward the drum to hold the roller against the surface of the drum.

In order to keep the swarf from building up and wedging in front of the roller 49, each arm 51 is pivoted in a clockwise direction to lift the shaft 50 away from the surface of the drum once during each revolution of the drum. This is accomplished through the use of cams 60 mounted on each of the arms for engagement by followers 61 which are mounted on the opposite ends of the drum adjacent the surface of the drum. As the drum rotates, the followers engage the cams overcoming the springs 57 to pivot the arms to lift the shaft 50 away from the surface of the drum. Preferably, the cams are generally pear-shaped members with their smaller ends mounted on the arms by pivots 63 (FIG. 4) to position the lower edges 64 of the cams for engagement by the followers to pivot the arms through a selected angle. The larger ends of the cams include arcuate slots 65 opening generally upwardly from the top edges 66 of the cams. Screws 67 are tightened down in the slots to hold the lower edges of the cams in place for engagement by the followers. Thus, with each revolution of the drum, the shaft 50 is lifted momentarily away from the drum as the followers 61 pass by the cams 60.

As shown in FIG. 6, the diameter of the shaft 50 is smaller than the diameter of the central opening 69 in the roller 49 thereby enabling the shaft to move transversely in the opening (see FIGS. 7 and 8) without lifting the roller from the surface of the drum 19. Herein, the difference between the diameter of the shaft and the diameter of the open is about one-eighth of an inch. Normally, with the springs 57 holding the arms 51 toward the drum, the shaft engages the bottom of the opening and holds the roller to squeeze against the drum surface. But, when the followers 61 engage the cams 60, the shaft may be lifted transversely within the opening as much as one-eighth of an inch before engaging the top of the opening, this depending upon the positioning of the cams on the arms.

Advantageously, the magnetic attraction of the drum 19 is utilized to keep the roller 49 from losing all its squeezing action when the shaft 50 is lifted within the opening 69. This is accomplished by constructing a portion of the roller of magnetic material so that even when the shaft is lifted within the opening, the roller will be held against the surface of the drum by the magnetic attraction of the drum, and thus the roller will continue to squeeze the coolant back into the tub. To this end, the roller includes magnetic steel core 70 in the form of a cylindrical sleeve which defines the inner wall of the opening and telescoped over the sleeve is a resiliently yieldable, elastomeric tube 71 the outer surface of which when pressed against the drum surface squeezes the coolant across the surface of the drum. Fitted within the opening 69 at the ends of the roller are nylon bushings 73 which provide wear surfaces for engagement with the shaft to avoid wearing of the inner surface of the steel sleeve 70.

As illustrated in FIG. 7 when in the normal squeezing position, the shaft 50 engages the bottom of the opening 69 to hold the roller 49 against the surface of the drum 19. Then, as the drum continues to rotate, the follower 61 engages the cam 60 by lifting the shaft 50 within the opening and away from the drum surface. If there is no buildup of swarf in front of the roller, the magnetic attraction of the drum for the steel sleeve 70

holds the roller against the drum surface with less pressure than is normal but with sufficient pressure to maintain some squeezing action. If, however, a pile of swarf such as is indicated by 72 in FIGS. 7 through 9 engages the roller, the latter is relatively free to move away from the surface of the drum to ride over the swarf and allow it to pass on toward the scraper 44. Since the roller is attracted toward the drum surface, the roller also squeezes coolant from the pile of swarf as the latter passes beneath the roller so that only a negligible amount of coolant is carried over with the swarf.

As shown in FIGS. 1 and 2, the exemplary roller 49 is comprised of a plurality of segments each mounted individually on the shaft 50 and corresponding to drum segments of the same length. The nylon bushings 73 are mounted in each of the ends of the roller segments and washers 74 (FIG. 2) between the adjacent ends of the segments keep the segments spaced properly along the shaft. This arrangement is of particular advantage in preventing the loss of coolant by carry over because the individual mounting of the roller segments permits one segment to ride up and over a pile of swarf without the other segments also lifting off the surface of the drum segments. This prevents the loss of coolant which otherwise would occur should the entire length of the roller be lifted off the surface of the drum 19 by riding over a pile of swarf.

In view of the foregoing, it will be apparent that the present invention provides a novel separator 15 which virtually eliminates the likelihood of swarf building up to jam the roller 49 against turning while at the same time avoiding any substantial loss of coolant by its being carried over with the rotating drum 19. This is accomplished through the use of the segmented roller 49 which includes the magnetic sleeve 70 and enlarged axial opening 69. Normally the shaft 50 holds the roller segments to squeeze against the drum, but when the follower 61 rides under the cam 60 the shaft 50 is lifted in the opening enabling the roller to ride up and over the swarf on the surface of the drum. Because of the magnetic attraction of the roller to the drum not all of the squeezing action of the roller is lost. Moreover, with the individual roller segments less coolant is lost as the segment rides up and over the swarf.

We claim:

1. A separator for use in removing magnetic swarf from a liquid comprising a frame, a tub supported by the frame and containing the liquid, a magnetized drum rotatably mounted on said frame and partially submerged in the liquid, power means for rotating the drum in the liquid whereby the swarf collects on the surface of the drum and is removed from the liquid, a scraper mounted in a fixed position on said frame to engage the surface of the rotating drum and scrape off the collected swarf, a squeegee roller mounted to engage the surface of the drum to squeeze liquid off the surface and back into the tub while at the same time rolling over the swarf collected on the drum to allow the swarf to pass on toward the scraper, and means mounting the roller on the frame and said means being movable between a normal position and a release position, said roller held against bodily movement away from the surface of said drum when said means is in said normal position and said roller being yieldably held against the surface of the drum for bodily movement away from the surface when said means is in said release position, and means for moving said mounting means between said positions so the roller may pass over a large pile of swarf and thereby keep the swarf from wedging between the roller and the drum to stall the roller while still squeezing liquid from the swarf and back into the tub.

2. A separator for use in removing magnetic swarf from a liquid comprising a frame, a tub supported by the frame and containing the liquid, a magnetized drum rotatably mounted on said frame and partially submerged in the liquid, power means for rotating the drum in the liquid whereby the swarf collects on the surface of the drum and is removed from the liquid, a scraper mounted on said frame in a fixed position to engage the surface of the drum and scrape off the collected swarf, a squeegee roller normally engaging the surface of the drum to squeeze liquid off the surface of the drum and back into the tub while at the same time rolling over the collected swarf to allow the latter to pass on toward the scraper, a shaft of a predetermined diameter telescoped into a larger diameter axial opening in said roller with the axis of the shaft spaced from and parallel with the axis of the opening, said shaft being movable within said opening to support the roller adjacent the surface of the drum for rotation about the axis of said opening, means mounting the shaft on said frame and normally holding the roller against bodily movement away from the surface of the drum, said mounting means momentarily lifting said shaft away from the drum and generally transversely within said opening as said drum rotates to enable the roller to ride over a large pile of swarf and thereby keep the swarf from wedging between the roller and the drum to stall the roller.

3. A separator as defined by claim 2 wherein a portion of said roller is fabricated from a magnetic material so that the magnetism of the drum pulls the roller yieldably toward the surface of the drum for squeezing against the surface when the shaft is lifted.

4. A separator as defined by claim 3 wherein said magnetic portion of the roller is a sleeve member telescoped into the roller and defining the axial opening.

5. A separator as defined by claim 3 wherein said roller comprises a plurality of segments each mounted on the shaft independently of the others and when the shaft is lifted each of the segments being independently movable to pass over a large pile of swarf without causing the entire roller to move away from the drum surface thereby avoiding the loss of all the squeezing action of the roller.

6. A separator as defined by claim 3 wherein said mounting means includes two spaced arms with pivotal ends mounted on said frame adjacent opposite ends of the drum and free ends connected to the opposite ends of said shaft to support the latter, said shaft being spring biased in a direction toward the surface of said drum, a cam connected to one of said arms, and a follower mounted on said drum to engage said cam to lift said shaft away from the surface of the drum.

7. A separator as defined by claim 6 wherein said cam is adjustable between positions on said arm to select the distance the shaft is lifted away from the drum when engaged by said follower.

8. A separator for use in removing magnetic swarf from a liquid comprising a frame, a tub supported by the frame and containing the liquid, a magnetized drum rotatably mounted on said frame and partially submerged in said liquid, power means for rotating the

drum in the liquid whereby the swarf collects on the surface of the drum and is removed from the liquid, a scraper mounted on said frame in a fixed position to engage the surface of the drum and scrape off the collected swarf, a squeegee roller mounted in a position to engage the surface of the drum to squeeze liquid off the surface of the drum and back into the tub before reaching the scraper, said squeegee roller comprising a plurality of roller segments each having a relatively thick outer sleeve of resiliently yieldable material for squeezing against the surface and a tubular member of magnetic material telescoped into said sleeve and defining an axial opening, means mounting the roller segments on the frame normally against movement away from the surface of the drum as the latter rotates and movable to hold the segments yieldably against the surface to roll over swarf accumulated in front of the segments, said mounting means including two spaced arms pivotally mounted on said frame adjacent opposite ends of the drum, a shaft connected between the free ends of said arms and movable therewith toward and away from the surface of the drum, said shaft being telescoped through the axial openings of said roller segments and having a diameter relatively smaller than the diameters of said openings, a spring connected with said arms to bias the shaft toward the surface of the drum and normally to hold the roller segments against movement away from the surface of the drum, a cam mounted on at least one of said arms, a follower mounted on the end of the drum for engagement with the cam to overcome said spring and pivot the arms to lift said shaft away from the surface of the drum generally transversely across the axial openings of said segments whereby the individual roller segments are held yieldably toward the drum by the magnetic attraction of the drum for the magnetic material in the segments thereby enabling the segments to move away from the surface of the drum independently of each other so that when one roller segment passes over another segments continue to squeeze against the surface of the drum.

* * * * *