Aug. 14, 1951 H. J. CALDWELL 2,564,593

MAGNETIC SEPARATOR

Filed March 1, 1947 3 Sheets-Sheet 1

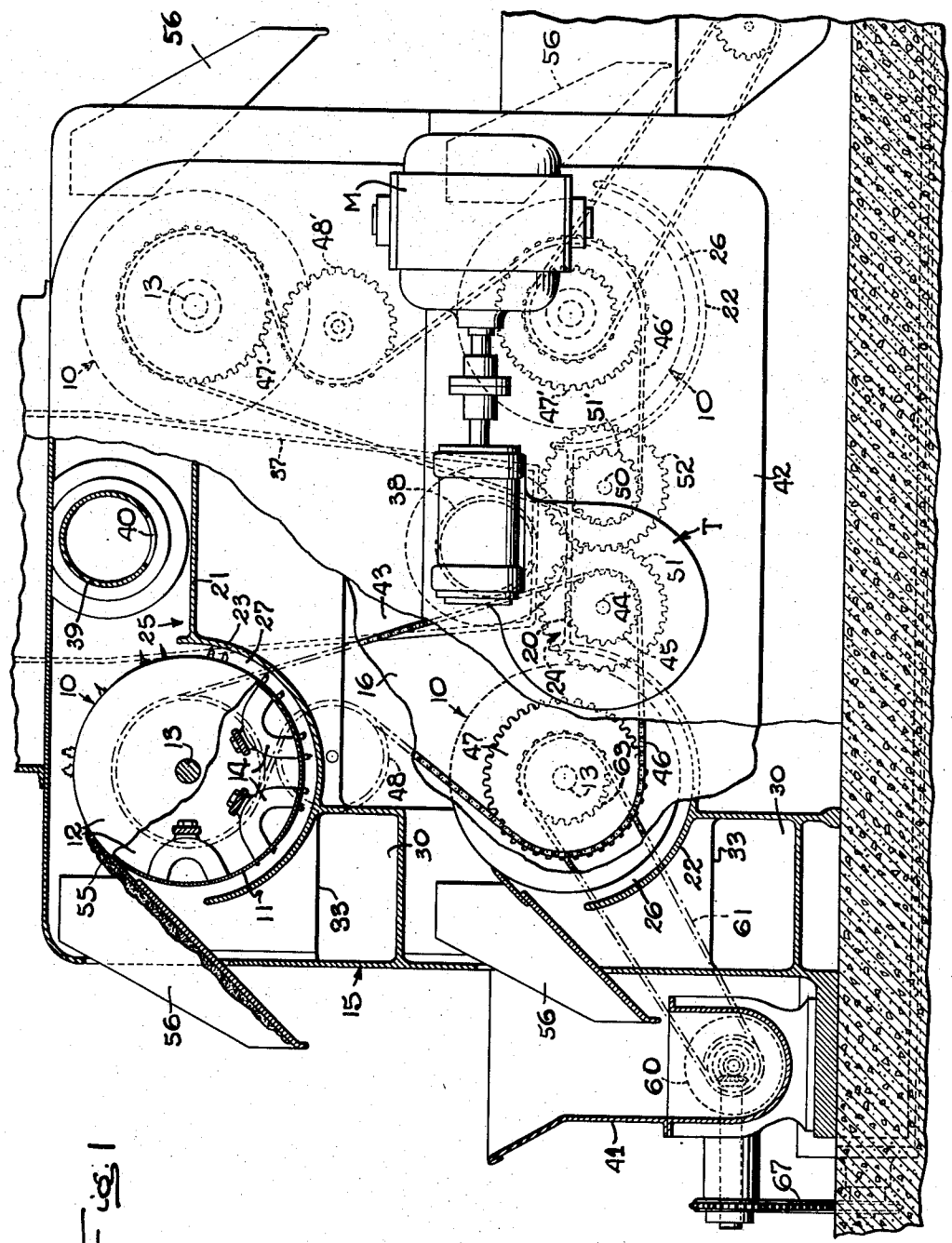



Fig. 1

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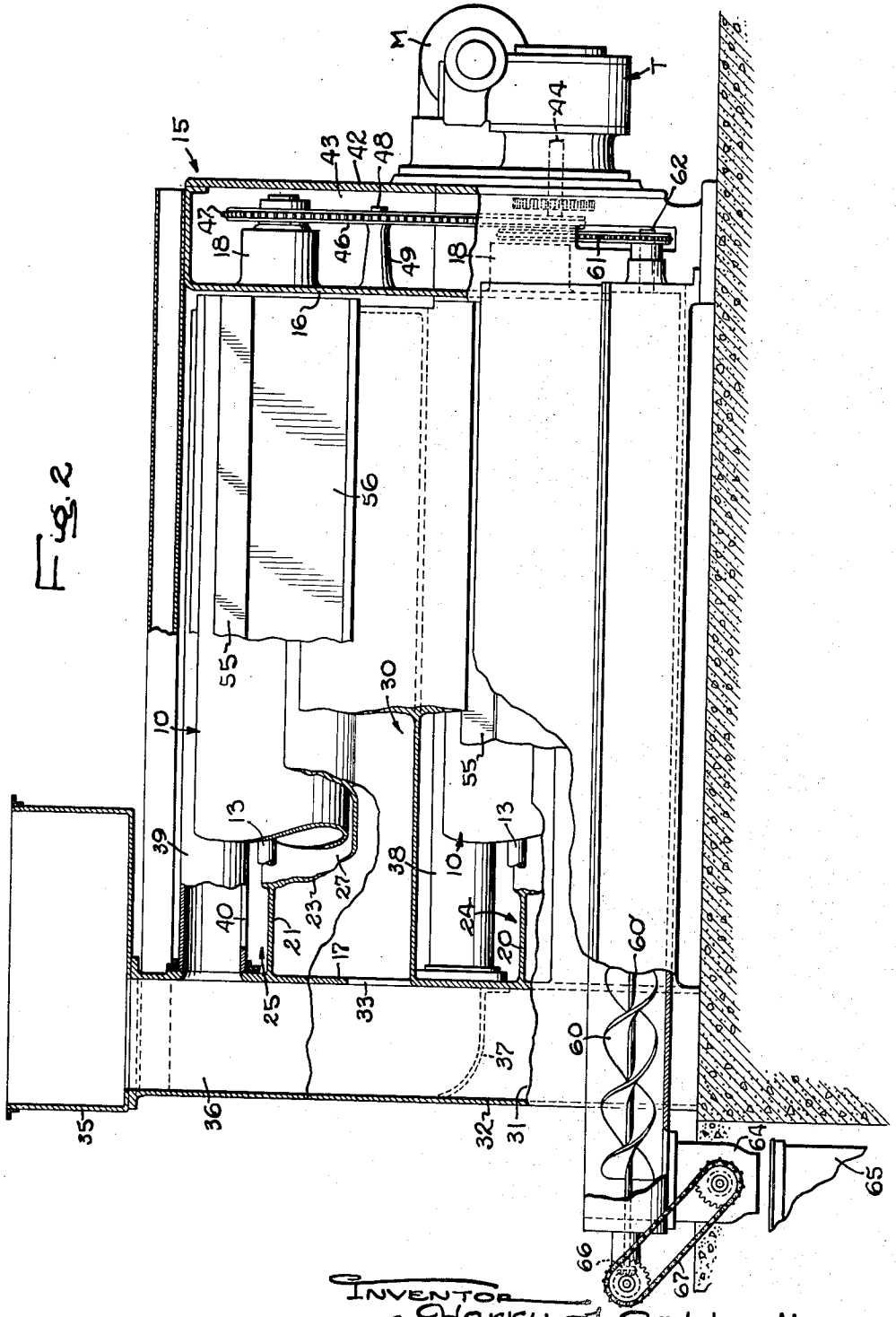



Fig. 2

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Fig. 3

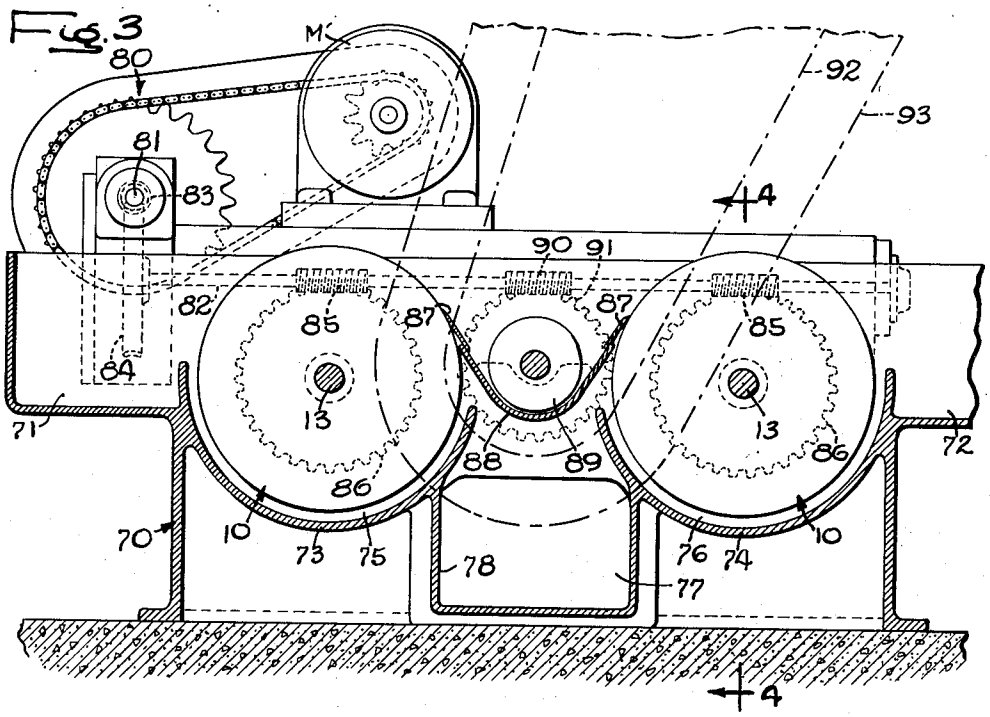
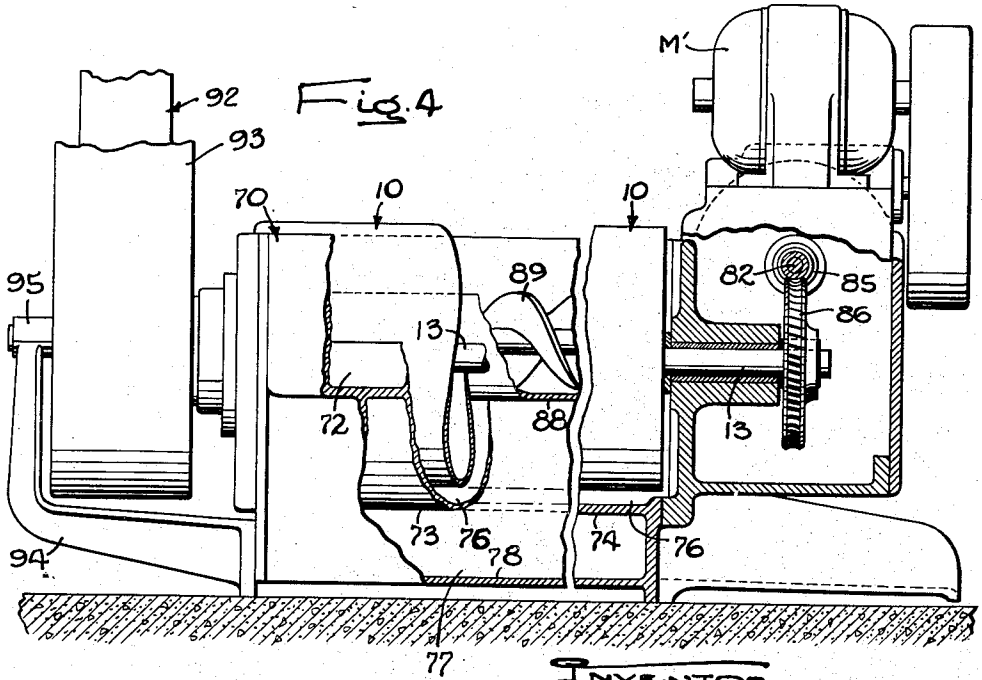



Fig. 4




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Patented Aug. 14, 1951

2,564,593

# UNITED STATES PATENT OFFICE

2,564,593

## MAGNETIC SEPARATOR

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Application March 1, 1947, Serial No. 731,854

2 Claims. (Cl. 210—1.5)

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The invention relates to the removal of foreign material from liquid coolant used in machining operations and more particularly to apparatus for treating the liquid coolant used in abrading operations to remove entrained metal and abrasive particles generally known as "swarf" therefrom.

One object of the invention is to provide unitary coolant treating apparatus of the above general character adapted to handle the liquid coolant used by a plurality of abrading machines and capable of operating continuously for long intervals without requiring periodic stops for cleaning or the like.

Another object is to provide a large capacity coolant treating apparatus which requires a minimum of shop floor space for its installation and which is capable of thoroughly and efficiently reconditioning large volumes of liquid coolant for use at a minimum cost per unit volume of the fluid treated.

It is also an object of the invention to provide coolant treating apparatus which by reason of its novel unitary construction can be produced economically in varying sizes to meet the requirements of a wide variety of shop conditions.

Other objects and advantages of the invention will become apparent from the following detailed description of the preferred embodiments in which:

Figure 1 is a partly sectioned end view of coolant treating apparatus embodying the features of the invention;

Fig.2 is a partly sectioned side view of the apparatus;

Fig. 3 is a transverse sectional view of a modified form of coolant treating apparatus; and

Fig. 4 is a longitudinal sectional view of the apparatus taken in a vertical plane substantially on the line 4—4 of Fig. 3.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment, but it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

In accordance with the invention, the improved

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apparatus, while relatively small and compact, is enabled to efficiently and thoroughly treat a large volume of liquid coolant by incorporating therein a plurality of continuously rotating magnetic drums 10 arranged in a novel manner to facilitate the flow of coolant through the apparatus and the removal of the swarf therefrom. More particularly, the magnetic drums are arranged in vertically and laterally spaced relation with suitable channels for delivering the coolant to and circulating it around the several drums and for continuously removing the swarf withdrawn from the coolant.

The magnetic drums 10 are preferably of the type disclosed in my copending application, Serial No. 710,564, filed November 18, 1946, now Patent No. 2,541,202. As herein shown, each drum comprises a hollow cylindrical shell 11 (Fig. 1) of nonmagnetic material closed at opposite ends by heads 12 keyed or otherwise nonrotatively secured to a shaft 13 of sufficient length to project at each end of the drum. Within the shell 11 a plurality of permanent magnets 14 of Alnico or the like are arranged in circumferentially spaced rows with their poles disposed closely adjacent the shell. The arrangement is such that the particles of magnetic material entrained in the coolant circulated around the drums together with a substantial part of the entrained abrasive particles are collected on the surface of the drum. The collected particles are withdrawn from the coolant by rotation of the drum and may be removed therefrom in any preferred manner.

The particular coolant treating apparatus illustrated is provided with four of the drums 10 arranged with their axes horizontal and in a generally rectangular formation, that is, with one pair of drums above the other, the drums of the respective pairs being spaced apart laterally. The drums 10 are rotatively supported in a rigid frame structure 15 including upright members 16 and 17 (Fig. 2) having suitable bearings 18 for receiving the ends of the shafts 13.

Coolant to be treated is directed into operative relation to the drums 10 through main and branch channels formed by members constituting, in this instance, a part of the frame structure 15. The channel forming members include a pair of elongated flat plates 20 and 21 extending substantially horizontally between the upright plates

16 and 17 and respectively having downwardly and outwardly projecting arcuate extensions 22 and 23 at opposite sides. The member 20 is disposed between the lower pair of drums 10 and the member 21 similarly disposed between the upper pair of drums with their arcuate extensions 22 and 23 partially encircling the adjacent drums.

As will be seen by reference to Fig. 1, the inner edges of the arcuate members 22 and 23 are extended somewhat above the upper surface of the associated members 20 and 21, thus forming shallow channels 24 and 25 for directing the flow of liquid coolant longitudinally of the apparatus. Moreover, the arcuate members 22 and 23 are spaced from the peripheral surfaces of the associated drums 10 so as to form therewith elongated shallow channels 26 and 27 opening from the main channels 24 and 25 and serving to direct the coolant flow over a substantial portion of the surface of each drum. The arcuate members are desirably constructed of magnet material and serve as shunt plates for concentrating the fields of the magnets 14 within the channels 26 and 27. The magnets are thus enabled to attract the entrained foreign particles from the coolant to the surface of the associated drums.

To ensure a flow of coolant through the branch channels, the outer edges of the arcuate members 22 and 23 are terminated in horizontal planes spaced slightly below the planes of the inner edges of the members. In the particular apparatus shown, the inner edges of the members are located slightly above the central axes of the associated drums while the outer edges of the members are terminated below such axes.

By reason of the above construction, the coolant undergoing treatment flows from the main channels 24 and 25 through the branch channels 26 and 27 and is discharged over the outer edges of the arcuate members 22 and 23. In the passage of the coolant through the branch channels, the foreign material is attracted to and held on the surfaces of the drums 10 and the clean coolant is discharged into trough-like channels 30 formed by suitable partitions in the frame structure. The clean coolant is then directed through vertical passages 31 (Fig. 2) at one end of the frame to a suitable tank or reservoir from which it may be withdrawn for reuse as required. As herein shown, the passages 31 are formed in the frame structure by the upright plate 17, an end plate 32 spaced therefrom and the side walls of the frame. Openings 33 in the upright plate 17 provide communication between the channels 30 and the passages 31.

Liquid coolant to be treated by the apparatus is received in a shallow tank 35 mounted in the frame structure 15 and communicating with the main channels 24 and 25 through a vertical passage 36 at one end of the frame. The passage 36 in this instance is defined by a generally V-shaped partition 37 interposed between the upright plates 17 and 32, as shown in Fig. 1.

To avoid objectionable splashing of the liquid coolant and to insure uniform distribution of the same through the branch channels 26 and 27, fluid is delivered to the main channels through tubes or pipes 38 and 39 located above and extending longitudinally of the said main channels. The pipes are open at one end to the passage 36 and are formed with downwardly facing longitudinal slots 40 through which the liquid is discharged into the channels. The slots are preferably dimensioned so as to restrict the flow of coolant to a rate within the capacity of the branch channels, thus effectually preventing overflow of coolant in the event of momentary increases in the rate of delivery to the apparatus.



To provide for uninterrupted operation of the apparatus, provision is made for rotating the magnetic drums 10 continuously whereby the swarf collected thereon is withdrawn from the branch channels 24 and 25 and discharged into suitable hoppers 41 located outside of the frame structure. In the exemplary apparatus, the drums are rotated by a common drive mechanism including an electric motor M and speed reducing transmission T which may be of any suitable character. The motor and transmission are supported on the outer face of an upright plate 42 closing one end of the frame as shown in Fig. 2. The plate 42 is spaced from the upright plate 16 to form a compartment 43 enclosing that part of the drive mechanism interposed between the drums 10 and the transmission T.

As will be seen by reference to Fig. 2, the transmission T has its terminal shaft 44 projecting into the chamber 43. The terminal shaft carries a sprocket wheel 45 (Fig. 1) for cooperation with a chain 46 running over sprocket wheels 47 rigid with the two drums 10 at the left side of the frame (as viewed in Fig. 1) and over an idler sprocket 48 journaled on a bracket 49 rigid with the frame plate 16. Thus both of the drums 10 are rotated slowly in the same direction, in this instance counterclockwise, as viewed in the drawing.

The companion pair of drums at the right side of the frame are rotated through the medium of an intermediate shaft 50 driven from the terminal shaft 44 through intermeshing gears 51 and 52. The shaft 50 carries a sprocket wheel 51' for cooperation with a chain 46' running over sprocket wheels 47' rigid with the companion drums 10 and over an idler sprocket 48' supported in the same manner as the sprocket 48. Due to the gear connection between the terminal shaft 44 and the intermediate shaft 50, the drums at the right side of the frame are rotated in a direction opposite to the direction of rotation of the other drums or clockwise as viewed in Fig. 1.

Means is provided for removing collected swarf from the magnetic drums 10 incident to their rotation and for discharging it into the hoppers 41. For this purpose, each drum is provided with an individual scraper blade 55 having one edge bearing against the surface of the drum. As herein shown, the blades 55 are carried by inclined spout members 56 mounted in the frame and projecting laterally therefrom above the hoppers 41.

To facilitate disposal of the swarf, each of the hoppers 41 is preferably equipped with means for conveying the collected swarf to a suitable discharge outlet. The conveying means, as herein shown, comprises an elongated screw 60 having a shaft 60' journaled in suitable bearings at opposite ends of the hopper. The screw is driven continuously by means of a chain 61 running over a sprocket 62 on the screw shaft 60' and a driving sprocket 63 carried by the shaft 13 of the lowermost drum of the adjacent pair.

In the particular apparatus shown, the conveyor enclosing portion of the hopper 41 is extended beyond the end of the frame structure 15 and is provided with a downwardly opening discharge tube 64 through which the collected swarf may be discharged into a removable container

65. To ensure an effective flow of the swarf, the discharge tube is provided with suitable feed mechanism driven from the conveyor screw by gearing 66 and a chain and sprocket connection 67.

In operation, a continuous flow of liquid coolant through the apparatus may be maintained for long periods without interruption for cleaning or the like. The untreated coolant enters the apparatus by way of the receiving tank 35 and after circulating through the passage 36, main channels 24 and 25 and branch channels 26 and 27, it is delivered thoroughly cleaned and conditioned for reuse through the channels 30 and the passage 31. The particles of foreign material or swarf entrained in the coolant is collected on the magnetic drum 10 and withdrawn from the coolant in a continuous operation. Such collected swarf is scraped from the drums and discharged into the hoppers 41 from which it is conveyed to suitable containers so that it may be removed without interrupting the operation of the apparatus. Thus liquid coolant used in abrading or other machining operations may be reconditioned for use in large quantities and at minimum cost.

In the modified form of coolant treating apparatus shown in Figs. 3 and 4, a pair of the magnetic drums 10 are supported horizontally in laterally spaced relation in an elongated frame 70. The outer side walls of the frame are shaped to provide a pair of main flow channels 71 and 72 extending longitudinally of the frame parallel to the respective drums. Arcuate members or plates 73 and 74 of magnetic material extend inwardly from the sides of the frame and partially encircle the drums 10 to form therewith shallow branch channels 75 and 76 by which the coolant from the channels 71 and 72 is directed into operative relation with the drum surfaces. Coolant discharged from the inner ends of the branch channels 75 and 76 is caught in a central channel 77 by which it is delivered to a suitable tank or reservoir for reuse. As shown in Fig. 3, the channel 77 is formed by a trough-shaped member 78 extending longitudinally of the frame structure between the drums 10.

Suitable drive mechanism is provided for continuously rotating the drums 10 to withdraw the collected swarf from the coolant. The drive means in its preferred form includes a motor $M^1$ mounted at one end of the frame and having a chain and sprocket driving connection 80 with a shaft 81 journaled in a bracket rigid with the frame. The shaft 81 in turn drives a transverse shaft 82 through the medium of a worm 83 cooperating with a worm wheel 84 keyed to the latter shaft. The shaft 82 is provided with a pair of worms 85 coacting with worm wheels 86 keyed to the supporting shafts 13 of the respective magnetic drums. One of the worms 85 is preferably formed with a left-hand thread while the companion worm is formed with a right-hand thread, thus serving to rotate the cylinders 10 in opposite directions. In the particular apparatus shown, the drum 10 at the left of the frame (as viewed in Fig. 3) is driven in a clockwise direction while the companion drum is rotated counterclockwise.

For removing collected swarf from the drums 10, each drum is provided with an elongated scraper blade 87 bearing against its periphery. The scraper blades 87 are secured to and supported by the side walls of the V-shaped trough 88 extending longitudinally of the frame 70 between the two drums. Thus as the drums rotate



the swarf is scraped off and discharged into the trough.

To permit continuous operation of the apparatus, the trough 88 is equipped with a screw conveyor 89 adapted to convey the collected swarf to a suitable discharge outlet. The screw conveyor may be driven from the shaft 82 through the medium of a worm 90 keyed thereto and cooperating with a worm gear 91, keyed to the conveyor shaft. In the particular machine illustrated, a second conveyor 92 (Fig. 4) is provided for carrying the swarf from the screw conveyor 89 to suitable disposal receptacles. To this end, the screw conveyor is arranged to discharge the collected swarf into a housing 93 enclosing the conveyor 92, herein shown as a belt type conveyor. The housing 93 is supported, in this instance, by a bracket 94 at one end of the frame 70, the bracket also having a bearing 95 for supporting the outer end of the conveyor screw 89.

It will be apparent from the foregoing that the invention provides apparatus of a novel and advantageous character for treating the liquid coolant used in abrading operations to condition the coolant for reuse. The improved apparatus is particularly well adapted for handling large quantities of liquid coolant and is capable of operating for extended periods without interruption for cleaning or other purposes. The unitary character of the construction, in particular the use of a plurality of similar magnetic drums, makes it practicable to construct the apparatus in various sizes to meet the requirements of different installations.

I claim as my invention:

1. Apparatus for removing swarf from liquid coolant used in abrading operations comprising, in combination, a frame, a pair of magnetic drums rotatably supported on said frame with their rotational axes horizontal and spaced apart laterally, means rigid with the frame forming coolant flow channels extending along the outer sides of the drums, arcuate frame members cooperating with said drums to form branch channels extending from said main channels and partially encircling said drums, frame members forming a trough shaped channel extending longitudinally of the frame between said drums for receiving the coolant passing through said branch channels, a trough shaped member extending longitudinally of the frame above said trough-shaped channel, outwardly-directed scraper blades carried on the side walls of said trough-shaped member cooperating with the respective drums and operative during rotation of said drums to remove collected swarf therefrom, a screw conveyor extending longitudinally of said trough shaped member, and a power driven transmission supported at one end of the frame for rotating said drums in opposite directions to move the peripheries thereof into contact with the respective outwardly-directed scraper blades, and for driving said screw conveyor to remove collected swarf from said trough-shaped member.

2. Apparatus for removing magnetic particles from liquid coolant used in abrading operations comprising, in combination, a frame, a pair of magnetic drums supported on said frame for rotation about horizontal laterally-spaced axes, frame members forming coolant flow channels extending along the outer sides of the drums, other frame members forming branch channels extending from said first-mentioned channels and partially encircling said drums, still other frame members defining a trough-like channel

located between said drums for receiving coolant passing through said branch channels, a hopper located between said drums in vertically spaced relation above said trough-like channel, outwardly-directed scraper blades cooperating with the respective drums adjacent their inner sides and operative during rotation of said drums to remove the collected particles from the peripheries thereof and to deposit said particles in said hopper, means cooperating with said hopper to remove collected swarf therefrom, and a power-driven transmission operative to rotate said drums in opposite directions to move the peripheries thereof into contact with the respective outwardly-directed scraper blades.

HARRY J. CALDWELL.




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