

June 18, 1963

P. H. GOELTZ
MAGNETIC SEPARATOR

3,094,486

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FIG. 1

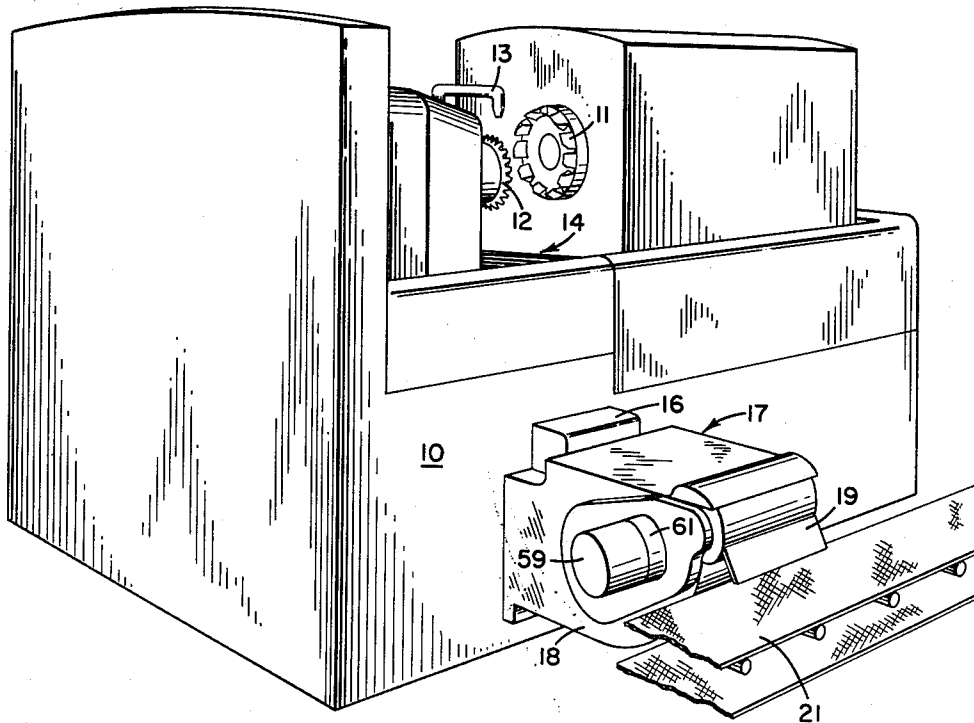


FIG. 5

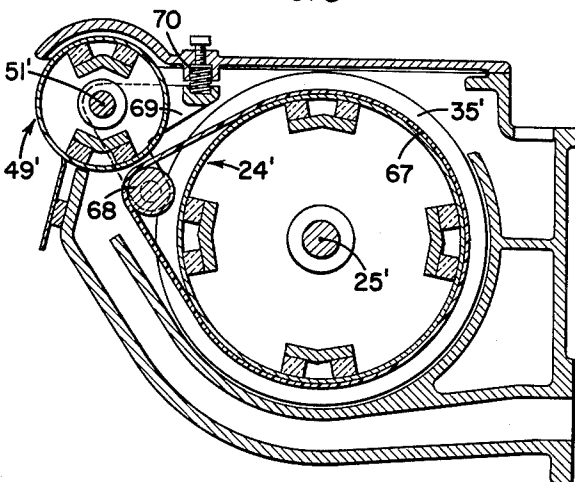
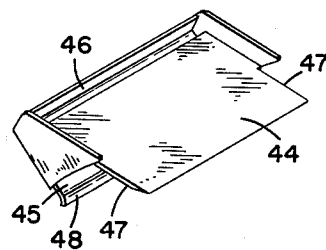


FIG. 4



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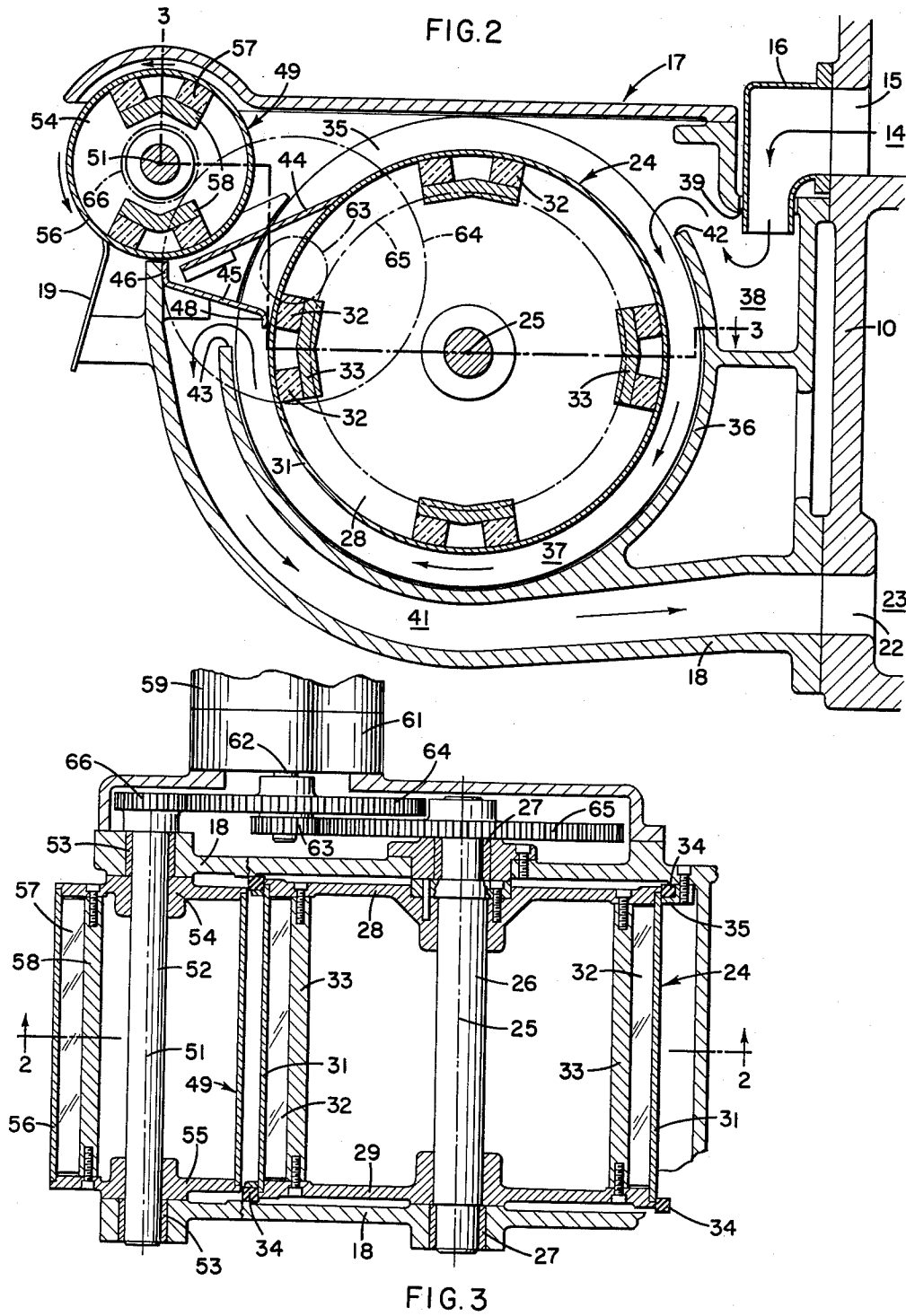
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MAGNETIC SEPARATOR

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The present invention relates to an apparatus for separating magnetic particles, such as iron and steel cutting chips, from cutting oil or other liquid with which they are admixed.

The cutting chips produced by metal cutting machines, such for example as gear cutting machines, and the finer particles or swarf resulting from grinding, are usually admixed with and carried by cutting oil or other coolant liquid, and it is necessary to remove them before recirculating the liquid. Magnetic separators have sometimes been used when the particles to be removed are magnetic, as is true of iron, steel and a number of iron alloys. In such separators the particle-carrying liquid is caused to flow beneath a rotatable drum which contains magnets which extract the metal particles. The latter are then removed from the drum by a suitable scraper arranged to act against the drum above the level of the liquid stream.

A serious disadvantage of such magnetic separators has been the loss of the substantial amounts of liquid which adhere to the drum and are entrapped between the drum and the metal particles and between adjacent particles, and hence are scraped off the drum with the particles. A primary object of the present invention is a separator which will substantially reduce this loss of liquid.

According to the invention the apparatus comprises a housing, first and second magnet-containing drums supported by the housing for rotation about spaced approximately horizontal axes, with the axis of the second drum at a higher level than that of the first drum, the magnets in each drum being peripherally disposed, drive means for rotating said drums, the housing having an arcuate apron extending in substantial concentricity with said first drum around the lower portion thereof and together therewith defining a passageway for liquid in which particles may be drawn magnetically to said first drum, said apron having at one end thereof a lip, over which the liquid may spill, for establishing the liquid level in said passageway, transfer means having a downwardly inclined surface departing approximately tangentially from an upper portion of the first drum, in the direction of rotation of the drum, for mechanically removing adhering particles and residual liquid, the second drum being above said liquid level established by said lip, said downwardly inclined surface extending in a plane beneath the second drum in such spaced relation thereto that the removed liquid may flow down said inclined surface past the second drum, without contact therewith, while particles on said inclined surface are magnetically drawn across an air gap to said second drum, and means for removing the particles from the second drum.

The foregoing and other objects and advantages of the invention will be understood from the following detailed description of the preferred embodiments shown in the accompanying drawings, wherein:

FIG. 1 is a perspective view of the separator attached to a bevel gear cutting machine;

FIG. 2 is a vertical section through the separator in plane 2—2 of FIG. 3;

FIG. 3 is a horizontal sectional view in planes 3—3 of FIG. 2;

FIG. 4 is a perspective view of a scraper and baffle unit of the separator; and

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FIG. 5 is a vertical section, similar to FIG. 2, through a modified separator.

The gear cutting machine comprises a frame 10 supporting a milling cutter 11 for cutting the teeth of an iron or steel gear 12. During the cutting operation oil or other coolant liquid is directed into the cutting zone through a nozzle 13, with the result that admixed oil and cutting chips fall into a chip chute 14, from which they are discharged, through an opening 15 in frame 10, FIG. 2, and elbow 16, into the separator 17 whose housing 18 is secured to the frame. From the separator the chips are discharged exteriorly of the housing, being directed therefrom by a scraper 19 of the separator unit onto an endless-belt type conveyor 21, while the liquid is returned through opening 22 in the frame to a sump 23 from which it is returned to the nozzle 13 by a suitable pump, not shown.

Referring particularly to FIGS. 2 and 3, a magnet-containing drum 24 is rotatable in the housing on horizontal axis 25. The drum comprises a shaft 26 rotatable in bushings 27 in the housing, and circular end plates 28 and 29 which telescope into and support a cylindrical shell 31. The latter is made of a non-magnetic stainless steel, while the end plates and the housing 18 are made of aluminum. Ceramic magnets 32 of bar form are mounted in pairs inside the shell, the magnets of each pair being bridged by and cemented to a steel keeper bar 33 of shallow V-cross section. The bars 32 are so magnetized that their pole faces contact the shell and the keeper bar, and those of each pair are of reversed polarity, so that each pair will have one north pole and one south pole against the shell. The keeper bars are secured to end plates 28, 29 by screws, as shown. Extending around each end of the drum and in substantially liquid tight contact therewith is a flexible sealing ring 34 which is secured to the housing by a backing ring 35.

The housing 18 has an integral and arcuate, approximately semi-circular apron 36 which extends around the lower portion of the drum and forms therewith a passageway 37 for liquid flowing from chute 14, this passageway extending from an inlet chamber 38, beneath fluid inlet opening 39 into the housing, into an outlet passageway 41 leading through opening 22 in the machine frame 10 to sump 23. The liquid in chamber 38 is maintained at a level at least as high as lip 42 of the apron, while liquid in passageway 37 is maintained at a level at least as high as the opposite lip, 43, of the apron.

Secured to the housing is the scraper-baffle unit, shown in perspective in FIG. 4, comprising a scraper 44 of spring bronze and a baffle 45 of stainless (non-magnetic) steel beneath the scraper. The scraper has an attenuated edge which contacts the drum 24 under spring pressure resulting from slight flexure of the scraper body. The scraper inclines downwardly from the line of such contact to its opposite edge which is spaced from an upturned flange 46 of the baffle. The side edges 47 of the scraper are in contact with the seal-backing rings 35. The baffle inclines downwardly from flange 46 to its opposite edge which has a downturned flange 48 in adjacent but spaced relation to the drum. The scraper 44 and also preferably the downturned baffle flange 48 are disposed above the level of liquid in passageway 37 which depends upon the height of lip 43 and the volume of liquid flow through the passageway 37.

A second magnet-containing drum 49 is supported for rotation above the scraper 44 on an axis 51 parallel to the scraper and to axis 25. As shown in FIG. 2, drum 49 is above the liquid level established by lip 43 and its axis 51 is at a higher level than axis 25. This drum is similar in construction to the drum 24, but smaller and contains only two pairs of magnets. It comprises a shaft

52 rotatable in bushings 53 in housing 18, aluminum circular end plates 54, 55 secured to the shaft, stainless (non-magnetic) steel shell 56, ceramic magnet bars 57, and keeper bars 58. The scraper 19, also of spring bronze, is secured at its lower edge to the housing and has its upper edge bearing lightly against the surface of the drum.

The two drums 24, 49 are driven in the same direction, counterclockwise in FIG. 2, by a motor 59 acting through a reduction gear unit 61 on whose output shaft 62 are a pinion 63 and a gear 64 for meshing respectively with a gear 65 on shaft 25 and a pinion 66 on shaft 52. The gearing of the particular apparatus shown is of such ratio that the peripheral velocity of drum 49 is about ten times that of drum 24, and that this velocity (of drum 49) is on the order of forty feet per minute.

In operation, metallic particles in the liquid flowing through passageway 37, in the direction of the arrows in FIG. 2, are drawn by the magnets 32 onto the surface of the drum 24. Some liquid adhering to or held by these particles, and by the drum itself, drains off by the time the particles reach the scraper 44, but a substantial amount remains, and, together with the particles on the drum, passes onto and down the scraper. As the particles approach the drum 49 they are drawn by the magnets 57 across an air gap between the scraper and the drum 49 onto the surface of the latter, such gap existing by reason of the adjacent surface of the scraper extending in a plane that passes beneath drum 49. The liquid remaining on the scraper flows onto the baffle 45 from which it is returned, over flange 48, to the main stream of liquid in passageway 37. The returning fluid has been found to be substantially free of magnetic particles, but any particle which does remain in the fluid is again subjected to the attraction of magnets 32 of the main drum 24, and hence is again returned to the scraper 44 for removal. The particles drawn onto drum 49 are detached therefrom by the scraper 19 which directs them onto the conveyor 21 or other suitable receiver.

Referring to the outer poles of the magnets 32 and 57, adjacent shell 31 or 56, the poles of each pair, i.e. of the two magnets bridged by one keeper 33 or 58, are much closer to each other than to the poles of other pairs in the same drum, to thereby provide a number of separate and distinct magnetic fields spaced around each drum. This arrangement has been found to facilitate flow of chips down the scraper 44 and the drawing of them onto drum 49.

In the modified separator shown in FIG. 5 the arrangement is basically the same as that described above, except that the scraper 44 is replaced by an endless flexible belt of nylon or other flexible non-magnetic material which serves to carry magnetic particles away from the large drum, 24', to which they are adhering magnetically, and bring them within the fields of the magnets of the small drum, 49', onto which they are drawn magnetically. The belt, designated 67, passes around the large drum 24' and around a non-magnetic roller 68 which is supported for rotation about a horizontal axis on a bracket 69. Preferably the belt is wide enough to cover the full width of the drum between the seal backing rings 35' at opposite ends of the drum. The roller-supporting bracket 69 is pivoted about axis 51' and is biased by a spring 70 to maintain the belt under tension. The drums 24', 49' may be driven by a motor and gearing substantially as shown in FIG. 3, or, if preferred, the drum 49' and the roller 68 may be driven by the motor and the drum 24' by the belt 67.

What is claimed as the invention is:

1. Apparatus for separating magnetic particles from liquid, comprising a housing, first and second magnet-containing drums supported by the housing for rotation about spaced approximately horizontal axes, with the axis of the second drum at a higher level than that of the first drum, the magnets in each drum being peripherally disposed, drive means for rotating said drums, the housing having an arcuate apron extending in substantial concentricity with said first drum around the lower portion thereof and together therewith defining a passageway for liquid in which particles may be drawn magnetically to said first drum, said apron having at one end thereof a lip, over which the liquid may spill, for establishing the liquid level in said passageway, transfer means having a downwardly inclined surface departing approximately tangentially from an upper portion of the first drum, in the direction of rotation of the drum, for mechanically removing adhering particles and residual liquid, the second drum being above said liquid level established by said lip, said downwardly inclined surface extending in a plane beneath the second drum in such spaced relation thereto that the removed liquid may flow down said inclined surface past the second drum, without contact therewith, while particles on said inclined surface are magnetically drawn across an air gap to said second drum, and means for removing the particles from the second drum.

2. Apparatus according to claim 1 in which the transfer means comprises a non-magnetic scraper contacting said upper portion of the first drum.

3. Apparatus according to claim 1 in which the transfer means comprises an endless belt extending around the first drum and also around a roller which is so positioned that the belt extends in said plane beneath the second drum.

4. Apparatus according to claim 1 in which the magnets of the first drum have a plurality of pairs of poles spaced around the periphery of the drum, with the poles of each pair more closely spaced to each other than to the poles of the other pairs of magnets, to thereby provide distinct and separate magnetic fields effective against particles on said downwardly inclined surface.

5. Apparatus according to claim 1 in which said drive means for rotating said drums are arranged to rotate the second drum at a higher peripheral speed than the first drum.

6. Apparatus according to claim 1 in which the magnets of each drum have a plurality of pairs of poles spaced around the periphery of the drum, with the poles of each pair more closely spaced to each other than to the poles of the other pairs of magnets, to thereby provide distinct and separate magnetic fields, and said drive means are arranged to rotate the second drum at a peripheral speed on the order of ten times that of the first drum.

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