May 6, 1958 G. W. WALTON ET AL 2,833,353

RETRIEVING TOOL

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Fig. 1

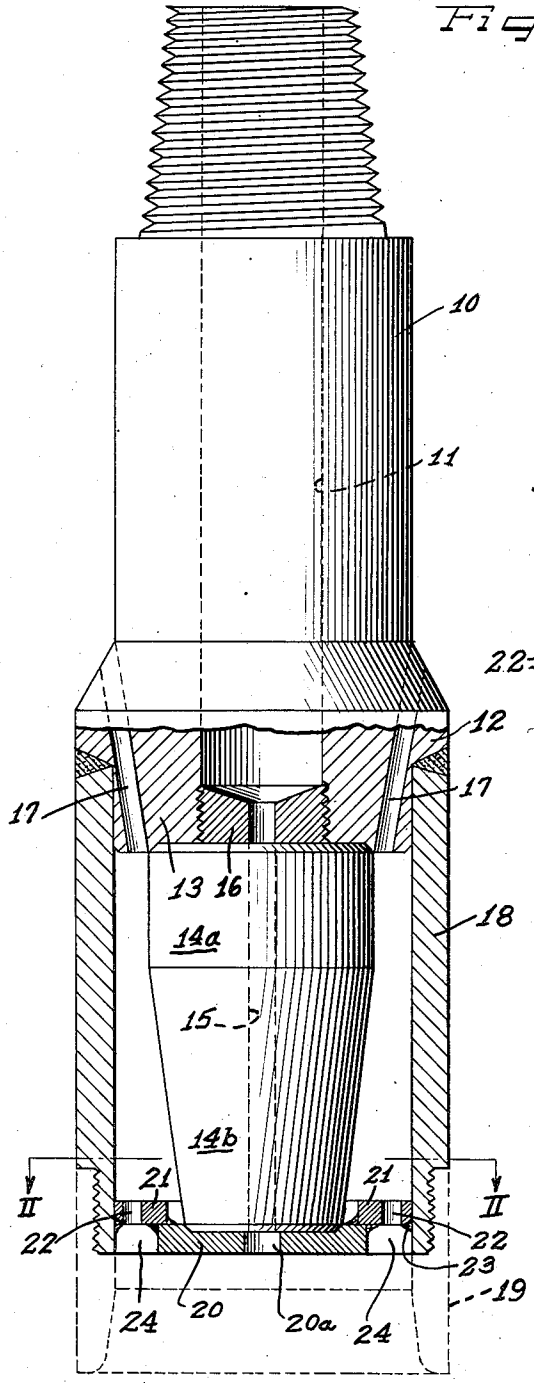
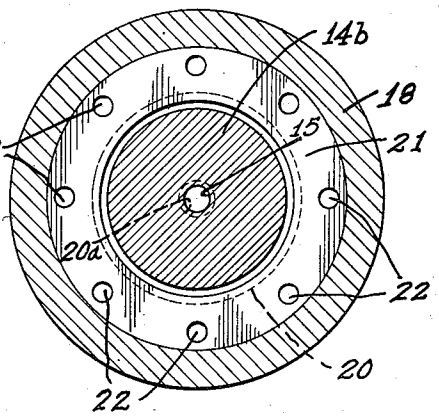


Fig. 2



Inventors
George W. Walton
Donald L. McCarty

by Lilly, Sherman, Morris, Good & Simpson Attys.

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Fig. 3

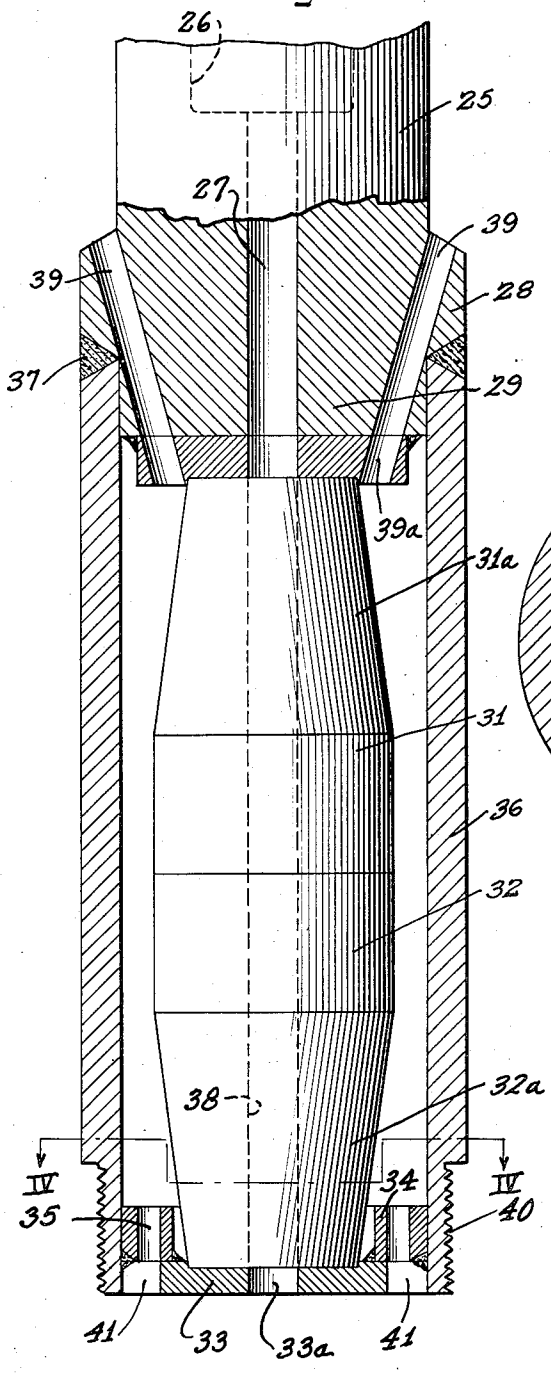
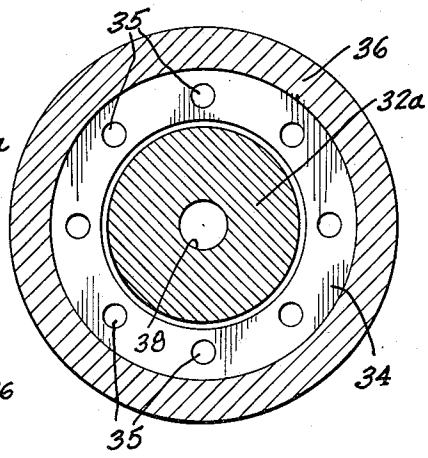


Fig. 4



Inventors
George W. Walton
Donald L. McCarty

by Hill, Sherman, Meroni, Gross & Simpson Attys.

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2,833,353

RETRIEVING TOOL

George W. Walton, Dallas, Tex., and Donald L. McCarty, Milwaukee, Wis., assignors to Ideco, Inc.

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7 Claims. (Cl. 166—65)

This invention relates to a retrieving tool and more particularly to a permanent magnet type tool which is adapted to magnetically engage and hold paramagnetic objects to permit withdrawal thereof from a drilled bore such as a well bore. Such objects as broken pieces of drill bits and other paramagnetic "junk" on the inner end of the bore frequently interfere with the drilling operation to such an extent that the removal thereof is imperative before such operation can efficiently proceed.

In most drilling operations it is customary to force a liquid through the drill pipe, a familiar example being the "mud" so used in the drilling of oil wells. This flow of liquid under pressure may be usefully employed with a magnetic retrieving tool in that fluid discharged under pressure through the tool tends to create a suspension of objects sought to be removed from the inner end of the bore and that facilitates engagement thereof with the magnet. In various tools heretofore provided for this purpose, however, the discharge of fluid under pressure from the tool has been through regions of high magnetic density resulting in a decrease in the magnetic efficiency of the tool. In such existing magnetic pick up tools entrance of fluid for return flow through the tool has been at regions of relatively low magnetic density so that the advantageous action of such return flow in moving objects into contact with the tool has been largely wasted.

The present invention overcomes such disadvantages by arranging for discharge of the fluid at a region of low magnetic density as through a coaxial passage in a bi-polar bar magnet, and by providing for return flow of the fluid through regions of high magnetic density between said magnet and a spaced surrounding shell. Such return flow further assists in moving the paramagnetic articles into pockets provided adjacent the inlet passages, which pockets being in regions of high magnetic density attract and hold therein a variety of paramagnetic objects engaged by the tool.

It is an important object, therefore, of the present invention to provide a magnetic retrieving tool having fluid discharge and inlet passages therethrough wherein fluid is discharged through the former at a region of low magnetic density and wherein fluid enters the latter at regions of high magnetic density.

It is specifically an important object of this invention to provide fluid discharge and inlet passages so arranged in a retrieving tool of the bi-polar bar magnet type having a surrounding casing.

It is a further object of this invention to provide a magnetic retrieving tool of the kind described wherein pockets are provided between the bar magnet and the casing for the reception of paramagnetic objects carried therein by magnetic attraction and the return flow of fluid.

It is also an object of this invention to provide a magnetic retrieving tool of the kind described which is of simple, durable and relatively inexpensive construction.

Other and further objects of this invention will be apparent from the disclosures in the specification and the accompanying drawings.

The invention (in a preferred form) is shown on the drawings and hereinafter more fully described.

On the drawings:

Fig. 1 is a central vertical section (with parts in elevation) taken through a magnetic retrieving tool embodying the principles of this invention;

Fig. 2 is a section on the line II—II of Fig. 1; and

Fig. 3 is a view similar to Fig. 1 showing the tool of this invention with a non-magnetic casing, and Fig. 4 is a section on the line IV—IV of Fig. 3.

As shown on the drawings:

In the form of this invention shown in Figs. 1 and 2, the magnetic retrieving tool is carried by a head portion **10** which is adapted to be attached to a string of drill pipe and which is provided with a longitudinal passage **11** through which fluid under pressure may be introduced into the tool. Said passage **11** is provided with an enlarged shouldered portion **12** and terminates in an extension **13** of lesser diameter than the shouldered portion and extending downwardly therefrom as shown in Fig. 1. Held tightly against the outer or lower face of the extension **13** of the head portion is a bi-polar bar magnet of unitary construction and formed of an alloy of high magnetic retentivity, such, for example, as the familiar iron, aluminum, cobalt and nickel magnet alloy. The bi-polar bar magnet preferably comprises an upper cylindrical section **14***a* and a lower frusto-conical section **14***b*, the lower section being made frusto-conical and of lesser diameter at its lower or outer end for a purpose to be described hereinafter. The bi-polar bar magnet is provided with an axial longitudinal fluid passage therethrough as shown at **15** and the reduction of the passage **15** in communication with the larger fluid passage **11** through the head **10** is provided by a passage plug **16** screwed into an internally threaded portion of the passage **11** through the head adjacent the juncture of the head and the upper end of the bi-polar bar magnet as seen in Fig. 1.

The passage **11** and its communicating axial passage **15** through the bi-polar bar magnet form a fluid inlet passage from which fluid is discharged into the end of the bore in a manner to be described hereinafter.

Fluid discharge passages **17** are provided in the extension **13** and shouldered portion **12** in the head **10** to permit of the return flow of fluid into the well bore in a manner which will also be described hereinafter.

Coaxial with the magnet and having its upper end abutting the lower face of the shoulder **12** which is firmly secured by welding, is a cylindrical casing **18** preferably made of a high-permeability, low-retentivity paramagnetic material, the lower end of the casing **18** being spaced from the bi-polar bar magnet **14***a*—**14***b* to a greater extent than the upper end thereof is spaced from the portion **14***a* of said bi-polar bar magnet. By reason of this reduction in magnet area and greater spacing at the lower end of the magnet and the enclosing cylindrical casing, maximum flux density is assured at the lower and active end of the retrieving tool. However, it is to be noted that a cylindrical bi-polar magnet with a circulation passage or passages at or near and parallel to its longitudinal axis may be used instead of the magnet **14***a*—**14***b*.

If desired, the lower end of the casing **18** may be fitted with a rotary shoe **19** made of the same metal as the casing and having an internally threaded portion engaging external threads of a shouldered portion at the lower end of said casing **18**. Tightly engaged against the lower end of the bi-polar bar magnet is a circular pole plate **20** made of tough paramagnetic material, such as low carbon steel. The pole plate **20** is provided with a central fluid passage **20***a* which communicates with the passage **15**

and the bi-polar bar magnet thus completing a fluid inlet passage from the passage **11** in the head **10**, through the passage **15** and outwardly through said passage **20***a* to discharge fluid under high pressure into a region of relatively low magnetic density.

The outer edge of the pole plate **20** is spaced from the inner face of the cylindrical casing **18** as clearly shown in Fig. 1 and the remainder of the gap between the outer edge of the pole plate and the inner face of the casing **18** is bridged by a spacer member **21** made of non-magnetic material, such, for example, as stainless steel. The spacer member **21** is provided with a plurality of fluid inlet passages **22** which permit of return flow of fluid therethrough upwardly through the space between the casing **18** and the outer face of the magnet and outwardly through the passages **17** previously described. This means that the return flow of fluid from the end of the bore is through regions of high magnetic density thus tending to move paramagnetic articles into position to be engaged and held at the bottom of the tool. It will be noted from an examination of Fig. 1, the non-magnetic spacer ring **21** is secured as by welding to the top and to the outer edge of the pole plate **20** and is further secured as by welding to the inner face of the casing **18**.

The pole plate **20** and the non-magnetic ring **21** are welded together, as shown, in Fig. 1. The non-magnetic ring **21** is welded to the casing by a weld **23**. If desired, the lower face of the extension **13** and the upper face of the pole plate **20** may be slightly depressed to interfit with the respective ends of the bi-polar bar magnet **14***a*—**14***b* to assist in holding the members in alignment.

It will be further noted that an annular pocket **24** is provided between the inner wall of the casing **18** and its lower end, the lower surface of the passaged non-magnetic ring **21**, and the outer edge of the pole piece **20**. This pocket serves to receive and hold small paramagnetic objects which are moved thereinto by the flow of fluid from the end of the bore into the casing and outwardly through the passages **17** and since these pockets are located in a region of high magnetic density, articles so moved thereinto are held firmly therein.

As will be apparent from the foregoing, the combination of the extension **13** on the head **10**, the casing **18** and the bi-polar bar magnet **14***a*—**14***b* provide a magnetic circuit which is of highest reluctance in the regions between the outer edges of the pole plate **20** and the inner face of the casing **18**. Thus, the return flow of fluid through the pocket **24** and passages **22** is in a direction to assist the magnetic attraction of a region of greatest magnetic density. Conversely, the flow of fluid through the passages **11**, **15** and **20***a* for discharge into the end of the bore is through a region of relatively low magnetic density (at the center of the pole of the bar magnet) and hence such flow of fluid under pressure through the passage **20***a* does not materially affect the magnetic efficiency of the tool, whereas the return flow of fluid through a region of high magnetic density enchances the efficiency of the tool in the picking up of paramagnetic objects.

Fig. 3 of the drawings illustrates another embodiment of the present invention wherein the advantageous outward flow of fluid through a region of low magnetic density and inward flow of fluid through regions of high magnetic density is attained in a bi-polar magnet type tool having a surrounding casing of non-magnetic metal.

The tool shown in Fig. 3 includes a head member **25** which is provided with a longitudinal passage **26** for the introduction therein of fluid under pressure. The passage **26** communicates with a reduced passage **27** which extends to the inner face of the head.

The head is provided with a shoulder **28** affording a stop for the upper end of a casing to be described hereinafter. Inside the shoulder **28** the head is provided with a cylindrical portion **29** extending below the shoulder. Abutting the inner face of the cylindrical portion **29** is a buffer or spacer member **30** of aluminum or other non-magnetic material which serves to magnetically insulate from the head a bi-polar bar magnet structure which will now be described. This bi-polar bar magnet structure preferably consists of two bi-polar bar magnets having cylindrical portions **31** and **32** placed in abutting relation with opposite poles in juxtaposition and respectively provided with integral frustoconical portions **31***a* and **32***a*, the former of which abuts against the buffer member **30** and the lower of which extends to terminate in a pole shoe or pole plate **33** centrally apertured at **33***a* and held in position by a spacer ring **34** tilted to the top of the pole plate, as shown in the drawings, and also secured by welding to the inside of the lower end of a casing **36** of non-magnetic material which surrounds the cylindrical portion **29** of the head and is secured to the shoulder **28** by welding, as shown at **37**. The casing **36** is coaxially positioned in reference to the magnet assembly **31**, **32** and that assembly is held affixed in its relation to the casing by the affixing of the spacer **34** to the pole plate **33** and and in turn by the affixing by welding or otherwise of the spacer **34** to the inner wall of the casing **36** near the lower end thereof.

The spacer **34** is provided with a plurality of return fluid passages **35** for a purpose to be described hereinafter.

The magnet assembly **31**, **32** is provided with an axial longitudinal passage **38** which in turn communicates at its upper end with a passage **38***a* in the buffer **30**, which latter passage communicates with the fluid inlet passage **27** in the head **25**. At its lower end the passage **38** communicates with the aperture **33***a* in the pole plate or pole shoe **33**.

Additional fluid discharge passages **39** are provided in the head **25** to permit of the discharge of fluid from the head at points at the upper face of the shoulder **28**. The passages **39** register and are in communication with passages **39***a* extending through the buffer **30**.

From the foregoing description it will be apparent that fluid under pressure introduced into the tool through a usual drill pipe (not shown) flows from passage **26** through the passage **27**, the aperture **38***a* in the buffer **30**, the passage **38** into the aperture **33***a* outwardly into the drill hole from which it is desired to pick up paramagnetic objects. This outward flow of fluid under pressure, as will be obvious, is through a region of low magnetic density so that the magnetic effort of the tool in picking up such objects is not diminished.

The return flow of fluid from the drill hole is inwardly through the passages **35** in the spacer **34** upwardly in the space between the magnet assembly **31**, **32** and the casing **36** and outwardly through the apertures **39***a* and passages **39**. This return flow, as will be seen, enters the tool at a region of high magnetic density so that the magnetic action of the tool is enhanced rather than diminished by such flow of fluid.

An annular pocket **41** is provided between the periphery of the pole plate **33**, the underside of the spacer member **34** and the lower end of the inner wall of the casing **36** and this pocket will tend to receive and magnetically hold small paramagnetic objects attracted therein by the magnetic force and sifted in their movement therein by the fluid discharge flow previously described.

The lower end of the casing **36** may be reduced and threaded as shown at **40** for reception of the rotary shoe, as shown in Fig. 1.

As will be noted in this particular embodiment of the instant invention, the return magnetic circuit is through an air path or a path of non-magnetic material. The spacer **34** and the buffer **30** magnetically insulate the magnetic assembly on the head and from the surrounding casing, although such insulation from the latter is not necessary in view of the fact that the surrounding casing **36** is made of non-magnetic metal such as stainless steel.

The frusto-conical portions **31***a* and **32***a* of the magnet assembly in reducing the cross-sectional area of the com-

posite bipolar bar magnet at its poles, likewise increase the magnetic intensity at those regions.

It will be apparent from the foregoing that this invention provides a tool of great magnetic strength, and one wherein the magnetic pick-up effort is not diminished by the flow of fluid under pressure from the end of the tool due to the fact that such flow is through a region of low magnetic density. At the same time the magnetic pick up effort is enhanced by the return flow of fluid into the casing through regions of high magnetic density.

It will be apparent that by this invention we have provided a simple magnetic retrieving tool making use of a powerful bi-polar magnet or bi-polar magnet assembly which is firmly held in position within the enclosing casing and which is so arranged in association with that casing and related fluid passages that the magnetic efficiency of the tool is not decreased by the flow therefrom of fluid under pressure or the return flow of fluid thereinto. Indeed, for reasons above noted, the magnetic pick-up efficiency of the tool is enhanced by this fluid flow arrangement.

We are aware that details of construction may be varied without departing from the principles of this invention and we, therefore, do not purpose limiting the patent granted hereon otherwise than necessitated by the scope of the appended claims.

We claim as our invention:

1. In a magnetic retrieving tool, a headed cylindrical casing of magnetic material having a fluid passage through the head thereof, a bi-polar bar magnet inside and spaced from the casing and having an end contacting the inner face of the head inside the casing and having a fluid passage therethrough communicating with the fluid passage in the head and discharging through the end of the magnet remote from the head, an apertured pole plate contacting said last mentioned end of the magnet with the aperture therein aligned with the fluid passage through the magnet, the pole plate projecting beyond the magnet toward the inner wall of the cylindrical casing at the end thereof remote from the head, and a passaged member of non-magnetic material secured to the top of the pole plate adjacent the outer edge thereof and also secured to the inner wall of the cylindrical casing to provide a pocket between said wall of the casing and the outer edge of the pole plate.

2. In a magnetic retrieving tool, a headed cylindrical casing of magnetic material having a fluid inlet passage through the head thereof, a bi-polar bar magnet inside and spaced from the casing and having an end contacting the inner face of the head inside the casing and having a fluid passage therethrough communicating with the fluid passage in the head and discharging through the end of the magnet remote from the head, an apertured pole plate contacting said last mentioned end of the magnet with the aperture therein aligned with the fluid passage through the magnet, the pole plate projecting beyond the magnet toward the inner wall of the cylindrical casing at the end thereof remote from the head, a passaged member of non-magnetic material secured to the top of the pole plate adjacent the outer edge thereof and also secured to the inner wall of the cylindrical casing to provide a pocket between said wall of the casing and the outer edge of the pole plate, and additional fluid passages formed in the head of the casing outside of the first mentioned fluid passage for discharging fluid which enters the casing through said passaged member and flows to said additional passages through the space between the magnet and the casing.

3. In a device of the kind described, a cylindrical casing of non-magnetic material, a passaged head enclosing one end of the casing except for an axial fluid inlet passage therein and fluid outlet passages spaced outwardly from said fluid inlet passage, a passaged buffer of non-magnetic material abutting the head on the inner side thereof with the passage therethrough registering with

the fluid inlet passage in the head and with additional passages therethrough registering with the fluid outlet passages in the head, a bi-polar bar magnet coaxially mounted within the casing and spaced from the walls thereof and having an axial fluid passage therethrough communicating with the fluid passage through the buffer against which an end of the magnet abuts, a pole plate at the other end of the magnet spaced at its periphery from the walls of the casing and having a fluid passage therethrough registering with the last mentioned fluid passage, a spacer member secured to the pole plate and to the inner wall of the casing and having passages therein communicating with the space between the magnet and the casing and thence with the fluid outlet passages in the head to permit the return flow of fluid.

4. In a device of the kind described, a cylindrical casing of non-magnetic material, a passaged head closing one end of the casing except for an axial fluid inlet passage therein and fluid outlet passages therethrough spaced outwardly from said fluid inlet passage, a passaged buffer of non-magnetic material abutting the head inside thereof, with the passage therethrough registering with the fluid inlet passage in the head having additional passages registering with the fluid outlet passages in the head, a bi-polar bar magnet coaxially mounted within the casing and spaced from the walls thereof and having an axial fluid passage therethrough communicating with the fluid passage through the buffer against which an end of the magnet abuts, a pole plate at the other end of the magnet spaced at its periphery from the walls of the casing and having a fluid passage therethrough registering with the last mentioned fluid passage, a spacer member secured to the top of the pole plate and to the inner wall of the casing to provide pockets defined by the perimeter of the pole plate, the outer surface of the spacer and the inner wall of the casing outside the spacer, said spacer having passages therethrough communicating with the space between the magnet and the casing and thence with the fluid passages in the head to permit return flow of fluid.

5. In a device of the kind described, a cylindrical casing of non-magnetic material, a passaged head closing one end of the casing except for an axial fluid inlet passage therein and fluid outlet passages therein spaced outwardly from said fluid inlet passage, a passaged buffer of non-magnetic material abutting the head inside thereof with the passage therethrough registering with the fluid inlet passage in the head having additional passages registering with the fluid outlet passages in the head, a plurality of bi-polar bar magnets abutting at opposite poles, coaxially aligned and spaced from the walls of the casing mounted within the casing and having registered axial fluid passages therethrough communicating with the fluid passage through the buffer against which an end of the endmost magnet abuts, a pole plate at the outer end of the other endmost magnet spaced at its periphery from the walls of the casing and having a fluid passage therethrough registering with the last mentioned fluid passage, a spacer member secured to the pole plate and to the inner wall of the casing and having passages therein communicating with the space between the magnet and the casing and thence with the fluid outlet passages in the head to permit return flow of fluid.

6. In a magnetic retrieving tool for well bores, a downwardly extending bar magnet having one pole at the bottom thereof defining a first zone of minimum flux density at the central portion of the bottom and a second zone of maximum flux density around the periphery of the bottom, a head member carrying the magnet and having a central passageway therein adapted to receive fluid from a drill pipe, said magnet having a centrally aligned aperture communicating with said central passageway and opening into said first zone for flowing fluid downwardly past said magnet, and means carried by the head member defining a second passageway in said second zone for return of fluid upwardly past said magnet.

7. In a magnetic retrieving tool for well bores, a downwardly extending bar magnet having one pole at the bottom thereof defining a first zone of minimum flux density at the central portion of the bottom and a second zone of maximum flux density around the periphery of the bottom, a head member carrying the magnet and having a central passageway therein adapted to receive fluid from a drill pipe, said magnet having a centrally aligned aperture communicating with said central passageway and opening into said first zone for flowing fluid downwardly past said magnet, and a casing carried by the head member surrounding and closely spaced from said magnet to define therewith a second passageway in

said second zone for return of fluid upwardly past said magnet.

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