May 14, 1963 G. C. CROOKS 3,089,724

MAGNETIC JUNK SUB

Filed Dec. 5, 1960 2 Sheets-Sheet 1

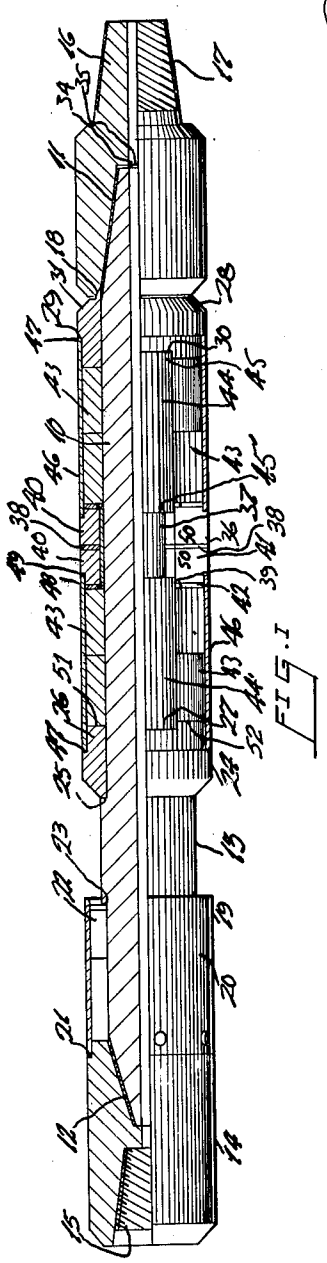


FIG. 1

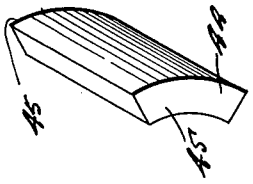


FIG. 5

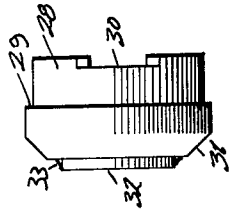


FIG. 4

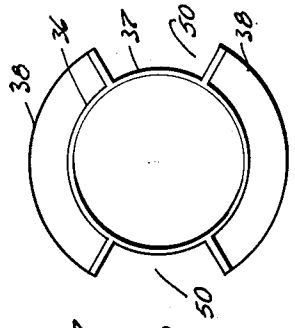


FIG. 3

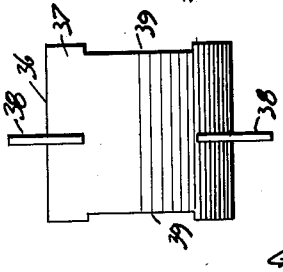


FIG. 2

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MAGNETIC JUNK SUB

Filed Dec. 5, 1960 2 Sheets-Sheet 2

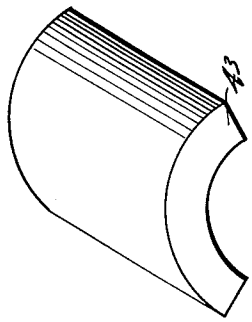
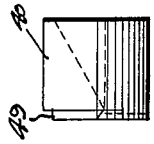


FIG. 8



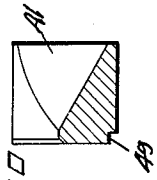


FIG. 10

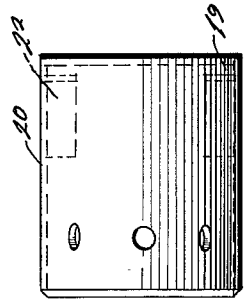
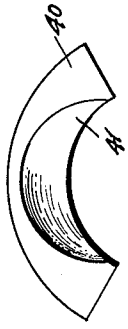


FIG. 7



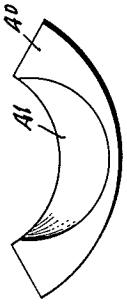


FIG. 9

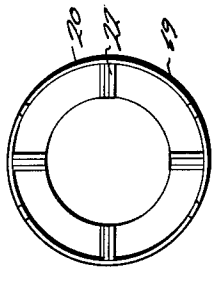


FIG. 2

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3,089,724

MAGNETIC JUNK SUB

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Filed Dec. 5, 1960, Ser. No. 73,812
12 Claims. (Cl. 294—65.5)

My invention relates to new and useful improvements in magnetic junk subs.

In the drilling and casing of oil wells, considerable magnetic junk occurs which can seriously damage the diamond drill bit normally used.

I have provided means for preventing the accumulation of said junk by the provision of a magnetic assembly situated preferably just above the drill head and in series with the drill stem which will attract and collect any magnetic junk occuring and retain same out of contact with the walls of the drill bore thus maintaining the drill bore in a relatively clean condition and preventing damage occuring through the drilling assemblies.

The principal object and essence of my invention is therefore to provide a device of the character herewithin described which is adapted to be situated above the drill head and to attract magnetic junk thereto for retention and eventual removal.

A further object of my invention is to provide a device of the character herewithin described which is easily assembled not only to a conventional drill stem string but also is easily assembled without bolts or screws, to the principal mounting tube.

Another object of my invention is to provide a device of the character herewithin described which is frictionally mounted upon the central supporting tube so that if jamming does occur between the device and the walls of the drill bore, the tube and drill stem string can continue to rotate but the magnetic assembly becomes stationary thus preventing damage occuring thereto.

Another object of my invention is to provide a device of the character herewithin described which incorporates a collecting basket below the magnetic assembly to catch junk which may be displaced partially during the withdrawal operation of the drill stem string.

Still another object of my invention is to provide a device of the character herewithin described which includes a plurality of sets of semi-circular magnetics so positioned and gapped that the magnetic flux concentrates towards the junk collector portion in the center and is then directed in a circular fashion thus concentrating the magnetic effect at the magnetic gaps.

A further object of my invention is to provide a device of the character herewithin described which is relatively simple in construction, economical in manufacture, and otherwise well suited to the purpose for which it is designed.

With the foregoing objects in view, and such other objects and advantages as will become apparent to those skilled in the art to which this invention relates as this specification proceeds, my invention consists essentially in the arrangement and construction of parts all as hereinafter more particularly described, reference being had to the accompanying drawings in which:

FIGURE 1 is a side elevation of my device sectioned along the longitudinal axis so that the upper portion of the view above the longitudinal axis is removed to show the interior thereof.

FIGURE 2 is a side elevation of the separator.

FIGURE 3 is an end view of FIGURE 2.

FIGURE 4 is a side elevation of one of the end pieces.

FIGURE 5 is a perspective view of one of the spacers.

FIGURE 6 is an end view of the basket.

FIGURE 7 is a side elevation of FIGURE 6.

FIGURE 8 is a perspective view of one of the magnetic elements.

FIGURE 9 is an end view of one set of the pole caps.

FIGURE 10 is a side elevation of FIGURE 9.

In the drawings like characters of reference indicate corresponding parts in the different figures.

Proceeding therefore to describe my invention in detail, reference should be made to the accompanying drawings in which I have illustrated a longitudinally extending main tube **10** having screw threaded tapered ends **11** and **12** and a shouldered portion **13** formed around the outer surface of the tube adjacent the end **12** thereof.

The tapered screw threaded end **12** is adapted to receive a standard coupler **14** which in turn is provided with internally screw threaded tapered end **15** to which can be attached one end of a conventional drill string (not illustrated).

A further coupler **16** is adapted to engage the screw threaded end **11** of the tube **10** and this coupler is provided with the externally tapered end **17** by which it may be secured to the adjacent length of drill rod (not illustrated).

From the foregoing it will be appreciated that the drill rod string rotative power is transmitted from one end to the other by the agency of the tube **10** which is centrally apertured so that the conventional lubricating and cleaning fluids can pass therethrough.

The coupler **16** is provided with an internal chamfer or taper **18** at the inner end thereof, the purpose of which will hereinafter become apparent.

A junk collecting basket **19** consisting of a cylindrical tube **20** is adapted to engage within a shoulder **21** on the inner end of the coupler **14** and is maintained in spaced and concentric arrangement with the tube **13** by means of a plurality of internally extending fins or lugs **22** welded to the inner surface of the tube **20**. These lugs bear against the outer surface of the tube **13** and the ends of the lugs butt up against one end **23** of the shouldered portion **13**, being held in place by the screw threaded engagement of the coupler **14** with the end **12**.

This forms a receptacle around the tube **10** which can retain any junk which may be displaced during the withdrawal of the device from the drill hole.

A cylindrical end piece **24** fits around the tube **10** and butts up against the other end **25** of the shouldered portion **13**, said end piece having a recessed shoulder portion **26** formed upon the inner end thereof and recesses **27** formed on the inner end thereof, the purpose of which will hereinafter be described.

A further end piece **28** is provided at the opposite end of the assembly and is shown in detail in FIGURE 4. This end piece also is cylindrical and is provided with a shouldered portion **29** and recessed portion **30**, the purpose of which will hereinafter be described.

However, upon the outer side or end **31** of this end piece **28** is a concentrically located cylindrical portion **32**, the periphery **33** of which is tapered to engage within the aforementioned taper **18** of the coupler **16**.

When the entire device is assembled, a relatively small clearance **34**, in the neighborhood of a few thousandths of an inch exists between one end of the tube **10** and the inner surface **35** of the coupler **16** and the tapered mating surfaces **33** and **18** act as a slip clutch for the assembly thus permitting same to remain stationary while the inner tube continues to rotate with the drill stem. This is because the only connection for rotation between the drill stem and the device is by the tapered frictional engagement of the walls **11**. If the assembly is tightened to the extent necessary to provide sufficient frictional engagement between these two portions, then of course the entire device will rotate with the drill stem. However if jamming occurs on the portion below the drill stem

then slippage will occur between these two portions thus preventing damage to the assembly. This prevents damage occurring to the assembly in the event that jamming takes place between the assembly and the walls of the drill hole.

A separator component **36** is situated around the tube **10** between the end pieces **24** and **28** and consists of a cylindrical portion **37** having a pair of arcuate fins **38** secured centrally thereon and extending radially therefrom as clearly shown in FIGURES 2 and 3. Furthermore the ends **39** of this separator are recessed as shown, the purpose of which will hereinafter become apparent.

FIGURES 9 and 10 of the drawings illustrate the pole pieces **40** which are arcuate in configuration and are internally formed as at **41**. These pieces are welded to the tube **37** of the separator one upon each side of each of the fins **38** and these pole pieces are manufactured of a magnetic transmitting material such as mild steel.

Inasmuch as the separator **37** is manufactured from a non-magnetic material, it will be appreciated that the fins **38** will act as a separator for the magnetic fields of the magnetic assembly hereinafter to be described.

Arcuately formed pole plates **42** extend around the tube **10** and against the ends of the aforementioned pole pieces **40**, the cross sectional configuration of the plates being similar to the cross sectional configuration of the pole pieces.

Beyond each of the pole plates are situated sets of magnetic elements **43** shown in detail in FIGURE 8. These are arcuate in shape and are adapted to register around the tube **10**, there being two sets upon each side of the separator **37** diametrically opposite one another with relation to the tube **10**.

Separating magnetic elements **43** from one another radially around the tube **10** is a plurality of arcuately formed spacers shown in FIGURE 5 and indicated by the reference character **44** so that around the perimeter of the tube **10** and upon each side of the separator **37** is a magnet, a spacer, a magnet and a spacer. The ends **45** of the spacers **44** are adapted to engage with the aforementioned recessed end **39** of the separator in order to locate the magnets accurately with relation to the separator and pole pieces.

A tubular retainer **46** surrounds the magnets and the spacers, one end **47** of the tube engaging the shouldered portion **26** of the end piece **24** and **28**, the other end **48** of the tube engaging recessed shoulders **49** formed on the pole pieces.

It should also be appreciated that the opposite ends **45'** of the spacers engage within the recesses **30** of the end pieces.

With the items mounted around the tube **10** as described, it will be apparent that tightening of the couplers **16** will clamp all of the components to the tube **10** in their desired relationship without the use of bolts, screws, etc. and that furthermore the components normally will rotate with the tube **10** but can remain stationary if jamming occurs.

The location and spacing the pole pieces **40** around the separator **37** will give a pair of diametrically opposite magnetic gaps or recesses **50**. If the ends **51** of the magnets upon one side of the tube **10** are north poles and the ends **52** of the magnets upon the other side of the tube **10** are south poles, magnetic flux is transmitted through the pole plates **42**, to the pole pieces **40** and are separated one from the other by means of the fins **38**. The opposing magnetic fluxes have thus only one direction in which they can flow and this is outwardly through the pole pieces at 90 degrees to the axis of the tube **10**. Here it sweeps around the outside of the pole pieces and, to a lesser degree around the shaped portions **41** thereof to the opposite and attracting pole piece ends where it forms a powerful attraction across the gap between opposing ends.

There is thus formed a very strong concentrated magnetic field sweeping the walls of the well bore and attracting junk into the magnetic gap between the two magnetic assemblies.

Since various modifications can be made in my invention as hereinabove described, and many apparently widely different embodiments of same made within the spirit and scope of the claims without departing from such spirit and scope, it is intended that all matter contained in the accompanying specification shall be interpreted as illustrative only and not in a limiting sense.

What I claim as my invention is:

1. A magnetic junk sub adapted to be secured in series with a drill stem string, comprising in combination, a non-magnetic longitudinally extending tube, a shouldered portion around said tube adjacent one end thereof, means on each end of said tube adapted to receive couplers of adjacent elements of said drill stem string, and a magnetic assembly frictionally mounted around said tube between said coupler and said shoulder, said magnetic assembly including a pair of spaced apart cylindrical end pieces surrounding said tube, one end of one of said cylindrical end pieces registering against said shouldered portion, one end of the other of said cylindrical end pieces being engaged by the adjacent end of one of said received adjacent drill string couplers, said magnetic assembly also including at least two sets of arcuately curved magnetic elements mounted around said tube and between said cylindrical end pieces, a pair of cylindrical sleeves surrounding said magnetic elements and engaging by one end of each thereof, said cylindrical end pieces, said magnetic assembly also including a centrally located magnetic separator around said tube and between said sets of magnetic elements, the other ends of said cylindrical tubes engaging said separator.

2. The device according to claim 1 in which said separator includes a cylindrical tube portion fitting around said first mentioned tube, a pair of radially extending fins centrally located on said tube portion and transversely thereto, and pairs of pole caps around said tube portion separated by said fins and adapted to form spaced gaps around said separator for the reception of junk magnetically attracted thereto.

3. The device according to claim 2 which includes pole plates between the said separator and said magnetic elements to concentrate the flux of said magnetic elements.

4. The device according to claim 1 in which one of said couplers has an internally tapered end portion, said end piece engaging said one coupler having an externally tapered end portion engageable by said coupler whereby said mating tapered surfaces rotate the components surrounding said tube, together with said tube, under normal circumstances but act as a slip clutch to said components if jamming occurs in the associated well bore.

5. The device according to claim 2 in which one of said couplers has an internally tapered end portion, said end piece engaging said one coupler having an externally tapered end portion engageable by said coupler whereby said mating tapered surfaces rotate the components surrounding said tube, together with said tube, under normal circumstances but act as a slip clutch to said components if jamming occurs in the associated well bore.

6. The device according to claim 3 in which one of said couplers has an internally tapered end portion, said end piece engaging said one coupler having an externally tapered end portion engageable by said coupler whereby said mating tapered surfaces rotate the components surrounding said tube, together with said tube, under normal circumstances but act as a slip clutch to said components if jamming occurs in the associated well bore.

7. The device according to claim 1 which includes a junk catching basket surrounding said tube but spaced from said magnetic assembly.

8. The device according to claim 2 which includes a junk catching basket surrounding said tube but spaced from said magnetic assembly.

9. The device according to claim 3 which includes a junk catching basket surrounding said tube but spaced from said magnetic assembly.

10. The device according to claim 4 which includes a junk catching basket surrounding said tube but spaced from said magnetic assembly.

11. The device according to claim 5 which includes a junk catching basket surrounding said tube but spaced from said magnetic assembly.

12. The device according to claim 6 which includes a junk catching basket surrounding said tube but spaced from said magnetic assembly.

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