Oct. 22, 1963 J. C. WOODS ETAL 3,107,742

APPARATUS FOR RECOVERY OF DRILL CUTTINGS FROM SUBSURFACE EARTH FORMATIONS

Filed Dec. 29, 1960 2 Sheets-Sheet 1

FIG. 1.

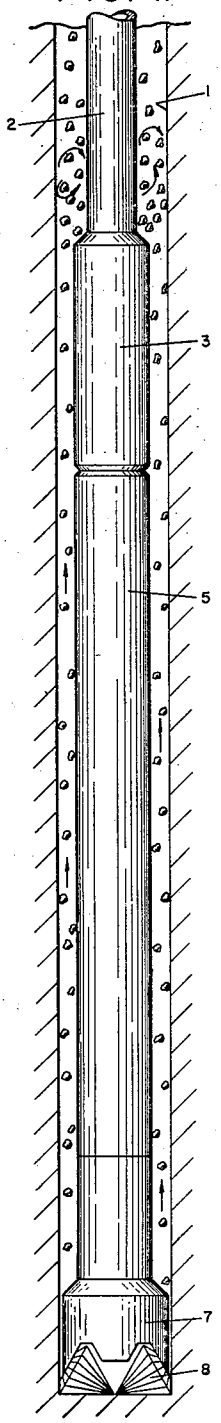
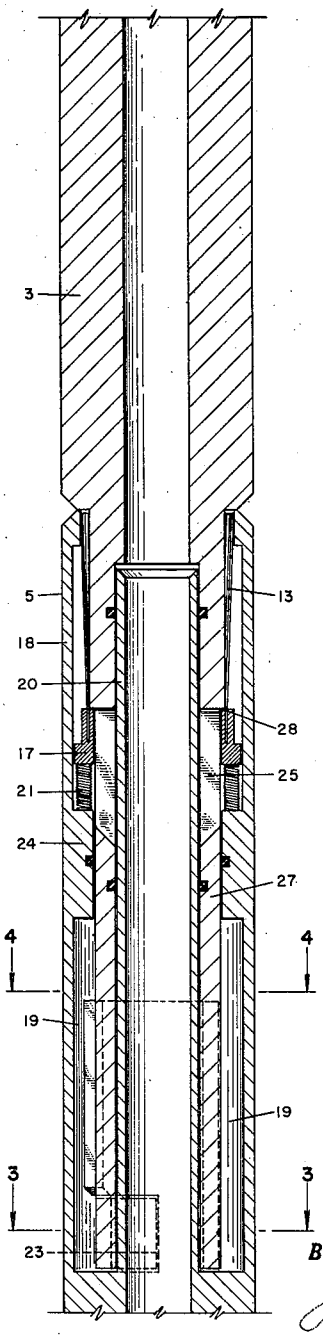


FIG. 2.



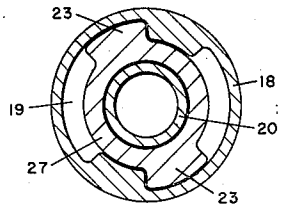


FIG. 3.

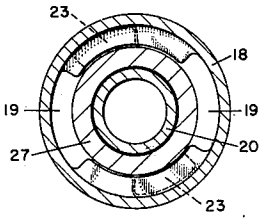


FIG. 4.

INVENTORS.
JAY C. WOODS,
WILLIAM E. KANADY,
BY John B. Davidson
ATTORNEY.

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FIG. 5a.

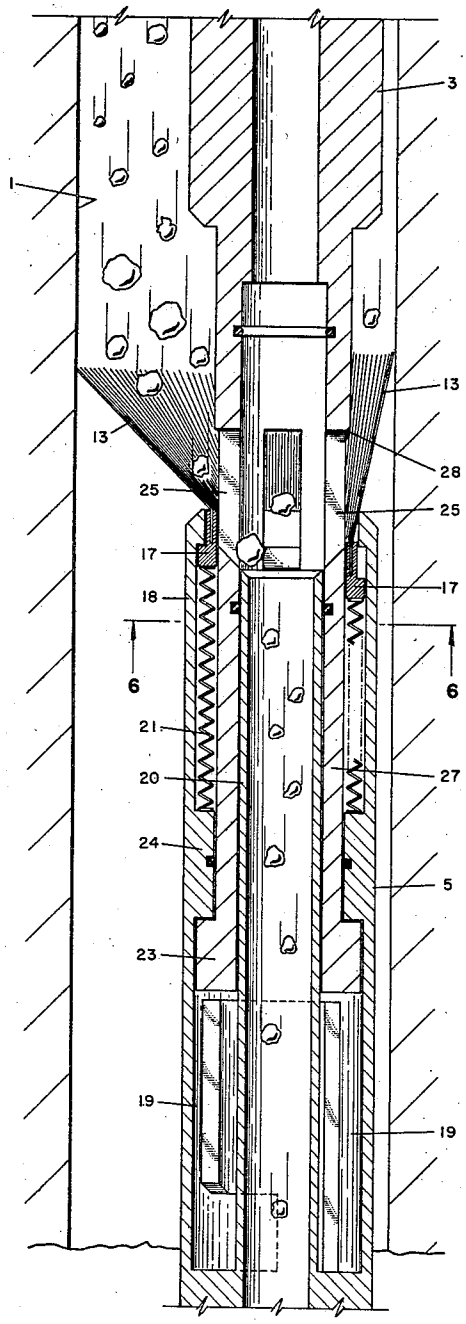


FIG. 5b.

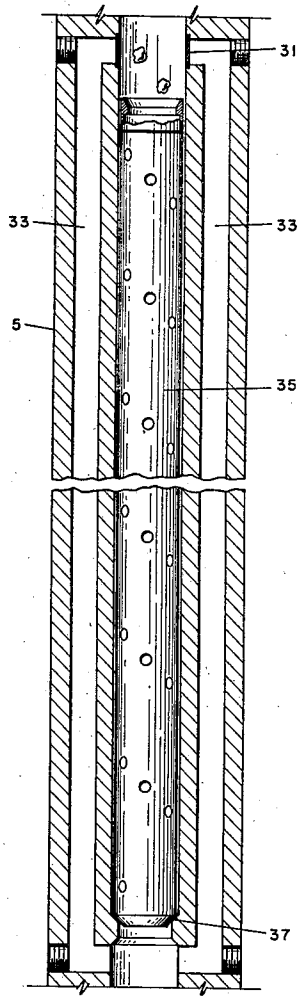
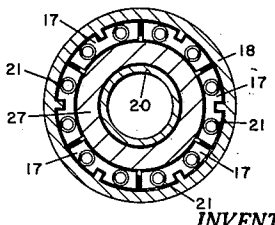


FIG. 6.



INVENTORS.
JAY C. WOODS,
WILLIAM E. KANADY,
BY John B. Davidson
ATTORNEY.

United States Patent Office 3,107,742 Patented Oct. 22, 1963

3,107,742

APPARATUS FOR RECOVERY OF DRILL CUTTINGS FROM SUBSURFACE EARTH FORMATIONS

Jay C. Woods and William E. Kanady, Houston, Tex., assignors, by mesne assignments, to Jersey Production Research Company, Tulsa, Okla., a corporation of Delaware

Filed Dec. 29, 1960, Ser. No. 79,307
8 Claims. (Cl. 175—309)

This invention relates generally to rotary drilling of boreholes, and more particularly to the problem of obtaining at the earth's surface chips produced during rotary drilling operations.

During rotary drilling of boreholes in the earth, it is the practice to circulate a drilling fluid down the bore of the drill pipe and up the annulus around the drill pipe. The drilling fluid passes out of the bottom of the drill pipe and around the drill bit to cool the drill bit and to remove rock chips from the bottom of the borehole. The chips are carried to the earth's surface with the drilling fluid. By capturing chips and analyzing them, geologists have been able to obtain much information about the earth formations penetrated by a bit soon after the chips have been cut. This technique has been practiced for many years using liquid drilling fluids of high viscosity. However, when either air or liquids of low viscosity (less than 1 centipoise) and low specific gravity (less than 3) is used as the drilling fluid, it has not been possible to obtain satisfactory earth chips. The drill string acts as a very effective rod mill to pulverize the rock chips during their long journey up the annulus to the earth's surface. When air is used as the drilling fluid, only dust rises from the annulus. In view of the known fact that air and low viscosity liquid drilling fluids are effective to increase drilling rate and prolong drill bit life in areas where such fluids may be used, it is desirable to have a method of capturing useful chips while drilling with such fluids.

Even when heavy liquids are used as the drilling fluid, cuttings from one formation tend to become mixed with cuttings from other formations above or below the one formation. For example, consider a group of cuttings that start the trip up the annulus together. Since the drilling fluid flow in the annulus is frequently laminar, the cuttings in the center of the annulus travel faster than those near the boundaries. Therefore, a cutting which finds itself in the center of the annulus may overtake cuttings from another formation which happen to be traveling near the edge of the annulus. Moreover, the cuttings are generated in a variety of sizes. In laminar flow the cuttings tend to fall or slip back through the drilling fluid with a velocity that can be approximated by Stoke's law. This means that small cuttings have a faster average velocity than large cuttings so that small cuttings from one formation may overtake large cuttings from another formation that was drilled earlier. Hole irregularities which always exist tend to add to this confusion of cuttings. The net result is that a geologist cannot be certain of the origin of the cuttings that he recovers at the surface.

In accordance with the teachings of the present invention, a valve, preferably an openable and closable port, is provided in the walls of the drill stem not far above the drill bit. In operative arrangement with the valve there is provided an earth cutting deflecting means for deflecting the earth cuttings falling downwardly in the borehole annulus, through the valve and into the drill stem bore. Preferably, the deflecting means comprises a plurality of stiff spring wires mounted on segmented annular carrier means so as to fan up and away from the drill pipe in the annulus around the drill pipe. The carrier means is mounted inside the drill pipe in a recess therein. The

wires and the carrier preferably are arranged so that the wires will retract into the drill stem when the valve is closed whereby the wires will be protected from possible damage while the pipe is rotating during drilling operations. The cuttings may be caught in a basket in the drill stem bore that can be raised to the earth's surface after the port is closed. The circulation of drilling fluid should be stopped so that earth cuttings may fall freely through the annulus and into the drill stem bore.

The objects and features of the invention will become more apparent upon consideration of the following detailed description thereof taken in connection with the accompanying drawings, wherein:

FIG. 1 is an elevational view of the lower portion of the drill stem in a borehole;

FIG. 2 is a cross-sectional view of a portion of the drill stem of FIG. 1 illustrating an embodiment of the invention in the while-drilling position thereof;

FIG. 3 is a cross-sectional view taken along section 3—3 of FIG. 2;

FIG. 4 is a cross-sectional view taken along section 4—4 of FIG. 2;

FIGS. 5A and 5B are cross-sectional views of the lower portion of the apparatus of FIG. 1 showing the component parts of the apparatus in the earth cuttings retrieving position thereof, and showing a cuttings basket in the drill stem; and

FIG. 6 is a sectional view taken along section 6—6 of FIG. 5A.

With reference now to FIG. 1, the lower portion of a drill stem is shown in a borehole 1 during drilling operations. The drill stem includes drill pipe 2, an upper drill collar section 3, a lower drill collar section 5, and a bit sub 7. A plurality of roller cone bit cutters 8 are affixed to the bit sub 7. The flow of drilling fluid is up the annulus around the drill stem so that earth cuttings are carried toward the earth's surface in the annulus.

With reference now to FIGS. 2 through 4, the upper drill collar section 3 and the lower drill collar section 5 are seen to be in partial telescoping reationship so as to be movable from a least telescoped position to a most telescoped position. The upper drill collar section 3 has an elongated section 27 of reduced diameter, terminating at its lower end in two or more drive lugs 23. Two drive lugs are illustrated in the figures. A plurality of port means 25 are provided in elongated section 27.

The lower drill collar section 5 terminates at its upper end in an inner tube 20 and an exterior sleeve member 18 that define a cavity or annular chamber within which the elongated section 27 is fitted. A plurality of J slots 19 are machined into the exterior sleeve 18 so as to receive the lugs 23. The J slots extend from an annular shoulder 24, that extends inwardly from the exterior sleeve 18, down to the lower end of the cavity. The J slots 19 and the lugs 23 form a releasable locking means and permit limited telescoping movement of the drill collar sections 3 and 5, and also provide a driving connection therebetween.

The port means 25 are positioned in the elongated section 27 so as to be immediately above the annular shoulder 24 when the drill collar sections 3 and 5 are in the most telescoped position thereof shown in FIG. 2. Annular segmented carrier members 17 are positioned in the annular chamber above the shoulder 24. The segments are individually biased upwardly by a plurality of coil springs 21. The coil springs 21 are supported on shoulder 24. Affixed to the carrier segments 17 are a plurality of elongated spring wires 13 that are crimped so as to normally extend upwardly and outwardly from the carrier members. The length of the wires preferably is such that when the drill color sections 3 and 5 are in the drilling position thereof illustrated in FIG. 1, the upper

ends of the wires will terminate at the upper end of the exterior sleeve 18. The lower portion of elongated section 27 is of slightly reduced diameter to provide a shoulder 28 at the upper end of the port means 25 which bears against the segments 17 to hold them down, as shown in FIG. 2.

With reference now to FIGS. 5A and 5B, the apparatus of FIG. 2 is illustrated in its nondrilling position for retrieving earth cuttings. When the drill collar sections 3 and 5 are in the least telescoped position thereof illustrated in FIG. 5A so that lugs 23 bear against the lower end of shoulder 24, the wires extend over the upper end of exterior sleeve 18 to contact the sides of the borehole 1. The reason for segmenting the carrier members 17 is readily apparent from FIG. 5A. It is desirable that the ends of all of the wires 13 contact the sides of the borehole. It is probable that the drill collars will be eccentrically disposed in the borehole so not all of the wires will contact the sides of the borehole unless the carrier member is segmented.

As illustrated in FIG. 5B, the lower drill collar section 5 has a landing means 37 therein for receiving a cuttings basket 35 which may be perforated so that drilling fluid can pass readily therethrough. The perforations, however, should not be so large that earth cuttings can pass therethrough. If desired, a wire cuttings basket may be used. One or more bypass passageways 33 are provided for the purpose of bypassing drilling fluid around the cuttings basket 35 during drilling operations. One or more screens 31 are provided at the upper end of the bypass passageways 33 to prevent large earth cuttings from passing through the bypass passageways 33 rather than falling into the basket 35.

Let it be assumed that earth cuttings are passing up the annulus around the drill stem as illustrated in FIG. 1. To retrieve earth cuttings, rotation of the drill stem is stopped and the upper drill collar 3 is rotated counterclockwise as viewed in FIGS. 3 and 4 and is lifted so that the drill collar sections 3 and 5 are in their least telescoped position. Segments 17 of the annular carrier member are likewise under the impetus of spring 21, and the wires 13 will extend up and over the upper end of exterior sleeve 18. Circulation of drilling fluid is cut off so that earth cuttings falling through the drilling fluid in the annulus will be caught by the wires 13 and deflected through port means 25 into the bore of the drill stem and into the cuttings basket 35. After a short interval of time, the upper drill collar section 3 is lowered and is rotated clockwise into its drilling position. The wires 13 will be retracted into the cavity between the elongated lower section 27 of drill collar section 3 and the exterior sleeve 18. The cuttings basket may be retrieved from the bore of the drill stem by conventional fishing means, and drilling operations may be recommenced. However, if it is desired to drill for a period of time and then obtain another sample of earth cuttings, this may be done without difficulty inasmuch as bypass passageways 33 insure that circulation of drilling fluid will be maintained even though basket 35 is partially filled with cuttings.

From the above discussion it is apparent that the inner tube 20 is for the purpose of preventing drilling fluid from damaging the segmented carrier member 17 and the coil springs 21 during drilling operations. The inner tube 20 should extend at least to the top of the port means 25 when the apparatus is in the position shown in FIG. 2.

If it is so desired, earth cuttings deflecting means other than the spring wires illustrated in the drawings may be used. However, the spring wires are preferred inasmuch as they are not readily damaged and provide a virtually foolproof mechanism.

From the above description it is readily apparent that the apparatus is simple and rugged. There is little possibility that any of the larger chips, which are the most valuable chips, can fall to the bottom of the borehole past the wires 13. Cuttings may be retrieved upon short notice with a minimum stoppage of drilling operations and with little effort on the part of the drilling crew.

The objects and features of the invention having been completely described above, what is desired to be claimed is:

1. Apparatus for use with an elongated basket in a tubular drill stem for recovering earth cuttings produced during rotary drilling operations in the earth, said apparatus including:

a first tubular drill stem section having landing means therein for holding the elongated basket;

a fluid bypass passageway in said first drill stem section adjacent said landing means for diverting drilling fluid around the cuttings basket;

said drill stem section at the upper end thereof including a tubular inner member and an outer sleeve member defining an annular recess and at least one J slot below said recess;

a second tubular drill stem section terminating at its lower end in an elongated portion extending through said annular recess, means on said elongated portion extending into said at least one J slot so that said first and second drill stem sections are in driving relationship and are adapted for limited telescoping movement between an extended position and a telescoped position;

an annular carrier member and spring biasing means therefor in said annular recess positioned between said first and second drill stem sections so that the carrier member is biased upwardly by the spring biasing means;

a plurality of stiff, elongated wire members fanning upwardly and outwardly from said annular carrier member to form an earth cutting deflecting means for deflecting toward said drill stem the cuttings falling downwardly in the annulus around the drill stem, said elongated wire members being adapted to retract into said recess as said carrier member is moved downwardly against said spring means;

said second drill stem section being spaced apart from the upper end of said first drill stem section to permit said wire members to extend up and over the upper end of said first drill stem section;

a plurality of port means in said second drill stem section positioned in alignment with said elongated wire members when said drill stem sections are in the extended position thereof;

the upper end of said port means defining a downwardly facing shoulder in said second drill stem section;

said carrier member and said port means being relatively positioned so that said shoulder on said second drill stem section engages said carrier member to force said carrier member downwardly as said drill stem sections are telescoped together, whereby said outer sleeve member covers said port means and said elongated wire members are retracted into said recess when said drill stem sections are in said telescoped position thereof.

2. Apparatus for use with an elongated basket in a tubular drill stem for recovering earth cuttings produced during rotary drilling operations in the earth, said apparatus including:

a first tubular drill stem section having landing means therein for holding the elongated basket;

said drill stem section at the upper end thereof including a tubular inner member and an outer sleeve member defining an annular recess and at least one J slot below said recess;

a second tubular drill stem section terminating at its lower end in an elongated portion extending through said annular recess, means on said elongated portion extending into said at least one J slot so that said first and second drill stem sections are in driving rela-

tionship and are adapted for limited telescoping movement between an extended position and a telescoped position;

an annular carrier member and spring biasing means therefor in said recess positioned between said first and second drill stem sections so that the carrier member is biased upwardly by the spring biasing means;

a plurality of stiff, elognated wire members fanning upwardly and outwardly from said annular carrier member to form an earth cutting deflecting means arranged and constructed to extend over the upper end of said first drill stem section for deflecting toward said drill stem the cuttings falling downwardly in the annulus around thed rill stem, said elongated wire members being adapted to retract into said recess as said carrier member is moved downwardly against said spring means;

said second drill stem section being spaced apart from the upper end of said first drill stem section to permit said wire members to extend up and over the upper end of said first drill stem section;

a plurality of port means in said second drill stem section positioned in alignment with said elongated wire members when said drill stem sections are in the extended position thereof;

the upper end of said port means defining a downwardly facing shoulder in said second drill stem section;

said carrier member and said port means being relatively positioned so that said shoulders engages said carrier member to force said carrier member downwardly as said drill stem sections are telescoped together, whereby said outer sleeve member covers said port means and said elongated wire members are retracted into said recess when said drill stem sections are in said telescoped position thereof.

3. Apparatus for use with an elongated basket in a tubular drill stem for recovering earth cuttings produced during rotary drilling operations in the earth, said apparatus including:

a first tubular drill stem section having landing means therein for holding the elongated basket;

a fluid bypass passageway in said first drill stem section adjacent said landing means for diverting drilling fluid around the cuttings basket;

said drill stem section at the upper end thereof including a tubular inner member and an outer sleeve member defining an annular recess;

a second tubular drill stem section terminating at its lower end in a portion extending into said annular recess, means on said portion mechanically connected to said first drill stem section arranged and constructed so that said first and second drill stem sections are in driving relationship and are adapted for limited telescoping movement between an extended position and a telescoped position;

an annular carrier member and spring biasing means therefor in said recess positioned between said first and second drill stem sections so that the carrier member is biased upwardly by the spring biasing means;

a plurality of stiff, elongated wire members fanning upwardly and outwardly from said annular carrier member arranged and constructed to extend over the upper end of said outer sleeve member to form an earth cutting deflecting means for deflecting toward said drill stem the cuttings falling downwardly in the annulus around the drill stem, said elongated wire members being adapted to retract into said recess as said carrier member is moved downwardly against said spring means;

said second drill stem section being spaced apart from the upper end of said first drill stem section to permit said wire members to extend up and over the upper end of said first drill stem section;

a plurality of port means in said second drill stem section positioned in alignment with said elongated wire members when said drill stem sections are in the extended position thereof; and

the upper end of said port means defining a downwardly facing shoulder in said second drill stem section;

said carrier member and said port means being relatively positioned so that the said shoulder engages said carrier member to force said carrier member downwardly as said drill stem sections are telescoped together, whereby said outer sleeve member covers said port means and said elongated wire members are retracted into said recess when said drill stem sections are in said telescoped position thereof.

4. Apparatus for use with an elongated basket in a tubular drill stem for recovering earth cuttings produced during rotary drilling operations in the earth, said apparatus including:

a first tubular drill stem section having landing means therein for holding the elongated basket;

a fluid bypass passageway in said first drill stem section adjacent said landing means for diverting drilling fluid around the cuttings basket;

said drill stem section at the upper end thereof including a tubular inner member and an outer sleeve member defining an annular recess;

a second tubular drill stem section terminating at its lower end in a portion extending into said annular recess, means on said portion mechanically connected to said first drill stem section so that said first and second drill stem sections are in driving relationship and are adapted for limited telescoping movement between an extended position and a telescoped position;

a segmented annular carrier member and individual spring biasing means for each of the segments of the segmented annular carrier member positioned between said first and second drill stem sections so that the carrier member segments are individually biased upwardly by the spring means;

a plurality of stiff, elongated wire members fanning upwardly and outwardly from said annular carrier member to form an earth cutting deflecting means for deflecting toward said drill stem the cuttings falling downwardly in the annulus around the drill stem, said elongated wire members being adapted to retract into said recess as said carrier member is moved downwardly against said spring means;

said second drill stem section being spaced apart from the upper end of said first drill stem section to permit said wire members to extend up and over the upper end of said first drill stem section;

a plurality of port means in said second drill stem section positioned in alignment with said elongated wire members when said drill stem sections are in the extended position thereof;

the upper end of said port means defining a downwardly facing shoulder in said second drill stem section;

said carrier member and said port means being relatively positioned so that said shoulder engages said carrier member to force said carrier member downwardly as said drill stem sections are telescoped together, whereby said outer sleeve member covers said port means and said elongated wire members are retracted into said recess when said drill stem sections are in said telescoped position thereof.

5. A tool adapted to be connected into a rotary drilling string for collecting earth cuttings from the well bore annulus during drilling operations, comprising in combination:

inner and outer drill stem sections concentrically ar-

ranged for longitudinal movement relative to each other from a telescoped position to an extended position, a central bore formed by said sections extending throughout the vertical length thereof;

means for releasably locking said sections in said telescoped position;

at least one port formed in one of said sections, said port being closed when said sections are in said telescoped position and open in said extended position;

annular deflector means arranged in said tool adjacent said port, said deflector means expansible into said annulus for deflecting said cuttings through said port into said bore when said sections are in said extended position;

said inner drill stem section being spaced apart from the upper end of said outer drill stem section above said annular chamber to permit said deflector means to extend up and over the upper end of said outer drill stem section into said annulus; and

means arranged in said bore for collecting said cuttings.

6. A tool adapted to be connected into a rotary drilling string for collecting earth cuttings in an elongated, retrievable cuttings collecting basket from the well bore annulus during drilling operations, comprising in combination:

inner and outer tubular drill stem sections connected in partial telescoping relationship and an annular chamber formed therebetween, said drill stem sections being adapted to be moved from a telescoped position to an extended position;

means for releasably locking said drill stem sections in said telescoped position;

portion means formed in said inner drill stem section, said portion being closed when said sections are in said telescoped position and open in said extended position;

a spring biased annular carrier member disposed within said annular chamber;

a plurality of stiff, elongated wire members fanning upwardly and outwardly from said carrier member and connected thereto, said wire members being extensible into said annulus for deflecting said cuttings through said port means into the bore of said drill stem when said sections are in said extended position;

said inner drill stem section being spaced apart from the upper end of said outer drill stem section above said annular chamber to permit said wire members to extend up and over the upper end of said outer drill stem section into said annulus;

landing means formed in said bore below said port means for holding the elongated, retrievable cuttings collecting basket; and

at least one passageway formed in said drill stem to divert drilling fluid around said basket.

7. A tool adapted to be connected into a rotary drilling string for collecting earth cuttings from the well bore annulus during drilling operations, comprising in combination:

inner and outer tubular drill stem section connected in partial telescoping relationship and an annular chamber formed therebetween, said drill stem sections adapted to be moved from a telescoped position to an extended position;

means for releasably locking said drill stem sections in said telescoped position;

port means formed in said inner drill stem section, said port being closed when said sections are in said telescoped position and open in said extended position;

a spring biased annular carrier member disposed within said annular chamber;

a plurality of stiff, elongated wire members fanning upwardly and outwardly from said carrier member and connected thereto, said wire members being extensible into said annulus for deflecting said cuttings through said port means into the bore of said drill stem when said sections are in said extended position;

said inner drill stem section being spaced apart from the upper end of said outer drill stem section above said annular chamber to permit said wire members to extend up and over the upper end of said outer drill stem section into said annulus;

an elongated, retrievable cuttings collecting basket positioned in said drill stem bore below said port means; and

at least one passageway formed in said drill stem to divert drilling fluid around said basket.

8. Apparatus adapted to be connected into a drill string for collecting earth cuttings in an elongated, retrievable cuttings collecting basket formed during rotary drilling operations, said apparatus including:

inner and outer tubular drill stem sections connected in partial telescoping relationship and an annular chamber formed therebetween, said drill stem sections adapted to be moved from a telescoped position to an extended position;

releasable locking means connecting said drill stem sections so as to releasably lock said sections in said telescoped position;

a plurality of spring biased arcuate segments circumferentially disposed about said inner drill stem section within said annular chamber;

a plurality of stiff, elongated wire members fanning upwardly and outwardly from said arcuate segments and connected thereto;

said wire members being extensible into the annulus around the drill stem to form an earth cuttings deflecting means when said drill stem sections are moved to said extended position;

said inner drill stem section being spaced apart from the upper end of said outer drill stem section above said annular chamber to permit said wire members to extend up and over the upper end of said outer drill stem section into said annulus;

a plurality of port means in said inner drill stem section positioned adjacent said wire members to communicate said annulus with the bore of said drill stem when said drill stem sections are in said extended position; and

landing means formed in said drill stem bore below said port means for holding the elongated, retrievable cuttings collecting basket.

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