Sept. 14, 1943. L. L. SNYDER ET AL 2,329,225

CORING DEVICE

Filed Dec. 3, 1940

Fig. 1.

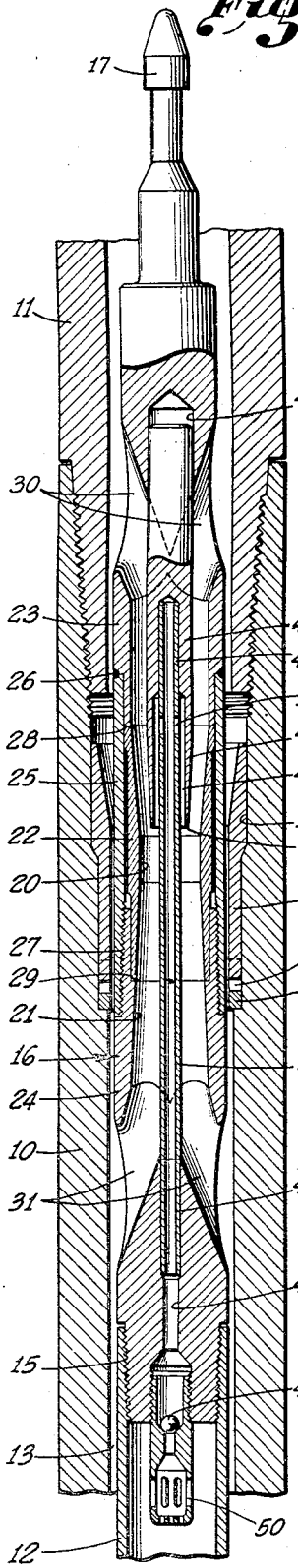


Fig. 2.

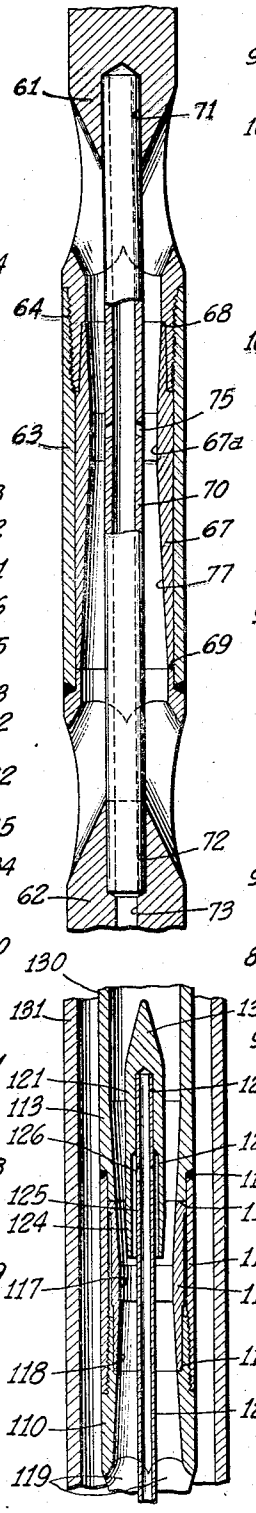


Fig. 3.

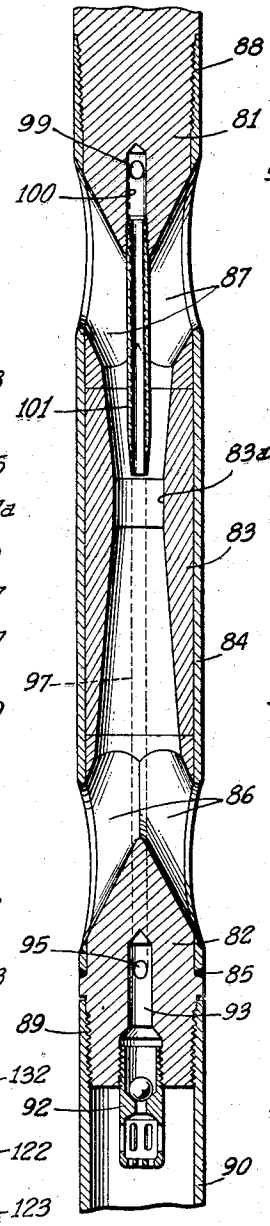


Fig. 4.

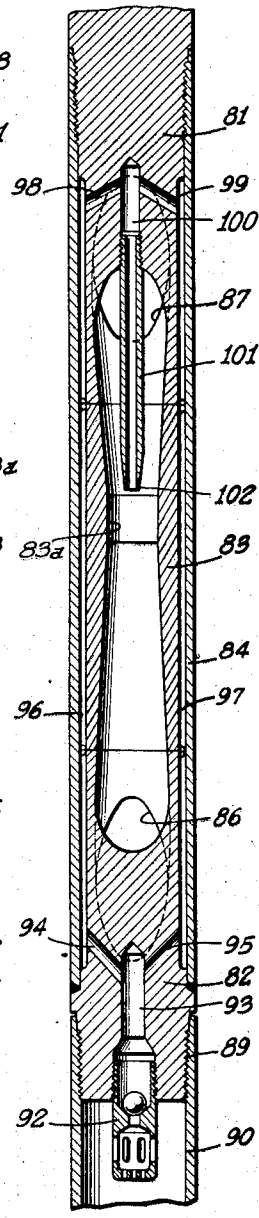


Fig. 5.

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UNITED STATES PATENT OFFICE

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CORING DEVICE

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Application December 3, 1940, Serial No. 368,332

16 Claims. (Cl. 255—72)

This invention relates generally to coring devices such as are employed in taking cores in oil wells and the like, and is directed particularly to improvements in such devices whereby more complete and cleaner cores may be obtained.

Core drills of the type employed in taking cores incidental to oil well drilling operations usually include an outer barrel secured to the lower end of a drill string and having a coring bit attached to its lower extremity, and an inner barrel mounted within the outer barrel and having an open lower end adapted to receive the core as it is cut. The inner barrel is usually spaced inwardly from the inner wall of the outer barrel to provide an annular circulation space between the barrels through which drilling fluid flows from the drill string to the discharge ports in the bit. An upwardly opening check valve is customarily provided at the upper end of the inner barrel to prevent the drilling fluid from entering the inner barrel through its upper end, while at the same time permitting fluid to escape from the upper end of the inner barrel as the core enters the lower end thereof.

It has long been recognized that in order to obtain maximum core recovery, particularly in soft formations, the pressure within the inner barrel must be reduced materially below the pressure of the drilling fluid as it enters the upper end of the outer barrel. The reason for this lies in the fact that the external pressure in the well bore adjacent the lower end of the inner barrel is considerably lower than the pressure of the drilling fluid before it enters the annular space between the barrels, due to the pressure drop occasioned by the restricted annular space between the barrels and the restricted discharge ports in the bit. If the pressure within the inner barrel were allowed to remain equal to the pressure of the drilling fluid above the annular space between the barrels, it would exert substantial back-pressure on the core, resisting its entry into the inner barrel and in many instances resulting in greatly reduced core recovery.

Various proposals have heretofore been made for reducing the pressure in the inner barrel, such as, for example, by evacuating the upper end of the inner barrel by the use of ejector nozzles disposed in the stream of drilling fluid flowing past the inner barrel. It has also been proposed to reduce the pressure in the inner barrel by the provision of a Venturi passage through which the drilling fluid is constrained to flow, and by establishing communication between the inner barrel and the throat of the venturi. This type of eduction device, when properly designed, is known to operate more efficiently than a jet type of nozzle because of the substantial reconversion of the velocity head back to pressure head on the downstream side of the Venturi passage. It has also proven to be more effective and more satisfactory in all respects than a jet type of nozzle for the present purpose. Examples of the use of Venturi passages in inner core barrels are found in U. S. Letters Patents No. 2,076,063, dated April 6, 1937, to Clarence E. Burt, and No. 2,108,949, dated February 22, 1938, to Leonard L. Snyder.

In operation, the ratio of the fluid velocity at the throat of the venturi to that in the annular space between the inner and outer barrels at a point below the venturi, is inversely proportional to the relative cross-sectional areas of the fluid passages at those points. In a theoretically perfectly designed venturi having a properly diverging discharge section below the throat, the only pressure loss through the venturi is that caused by friction, and in such instance the reduction in pressure at the throat is proportional to the increase in velocity at that point.

Unfortunately, space limitations in a core barrel are such as to render it extremely difficult to provide the desired constriction at the throat and a properly designed diverging discharge section while at the same time maintaining streamline flow in the fluid. Any abrupt deflection of the stream causes turbulence and eddies which not only decrease the efficency of the device, but also result in rapid abrasion of the metal surfaces contacted by the abrasive liquid.

A principal object of this invention is to provide an improved eduction device for core barrels, wherein the eduction effort is increased and at the same time abrasion of parts is reduced to a minimum.

A further object is to provide an education device of simplified design permitting the easy replacement of parts subject to wear.

The manner in which these and other objects are accomplished will become apparent from the following detailed description of a preferred embodiment of the invention, reference being had to the accompanying drawing wherein:

Fig. 1 is a central longitudinal sectional view of the upper portion of a core barrel, and illustrating one embodiment of the invention;

Fig. II is a fragmentary longitudinal sectional view of a modified form of the invention;

Fig. III is a view similar to Fig. II illustrating a further modification of the invention;

Fig. IV is a view of the device shown in Fig. III, taken in an axial plane at right angles to Fig. III; and

Fig. V is a fragmentary sectional view of a modification of the device of Fig. I, adapted to use in a conventional core barrel.

Referring to Fig. I, the reference numeral 10 designates the upper portion of an outer barrel, which is adapted to be connected to the lower end of a drill string by a suitable sub, the lower portion of which is shown at 11. The outer barrel is of suitable length to house an inner barrel 12, and is connected at its lower end to a core cutting bit (not shown). The lower end of the inner barrel 12 is open to receive the core as it is cut, and is adapted to seat on a shoulder in the bit in a conventional manner. In accordance with usual practice, the inner barrel is spaced inwardly from the inner wall of the outer barrel to provide an annular fluid channel 13 between the barrels, through which drilling fluid is pumped downwardly to the bit.

Detachably secured to the upper extremity of the inner barrel 12, as by a threaded connection at 15, is an eduction device, generally designated 16, embodying novel features forming the subject matter of this invention. For purpose of illustration, the invention has been shown as incorporated in what is known as a "wire-line" core barrel adapted to be lowered from the surface through the drill stem and subsequently removed, with a core contained therein, by a wire line without removing the drill string. To permit the attachment of a wire line to the barbel when it is to be raised to the surface, a spearhead 17 of conventional shape is formed on the upper end of the eduction assembly and is adapted to be engaged by the usual overshot secured to the lower end of the wire line.

The eduction device 16 embodies as its essential feature a Venturi passage having a constricted throat 20 intermediate its ends and an elongated, gradually diverging discharge passage 21 therebelow. Inasmuch as the throat 20 constitutes the region of highest fluid velocity, the abrasion of the surfaces by the drilling fluid reaches a maximum at that point and for this reason we prefer to form the central portion of the device as a separate, replaceable throat piece 22. To facilitate the removal and replacement of this part, the eduction device 16 comprises generally an upper section 23 and a lower section 24, interconnected by an intermediate sleeve portion 25. As shown, the sleeve is permanently secured to the upper section 23 as by welding at 26, and is threadedly connected at 27 to the lower section 24. The replaceable throat piece 22 is rigidly clamped between opposed shoulders 28 and 29 on the upper and lower sections 23 and 24, respectively, but may be removed upon disengagement of the threaded connection 27.

A pair of downwardly converging inlet ports 30 are provided in the upper section 23, and a pair of similar but downwardly diverging ports 31 are provided in the lower section 24. It will be observed that these ports are disposed at a relatively small angle to the longitudinal axis of the device, in order to minimize the deflection of the stream of liquid and thus avoid eddies which cause rapid abrasion of the parts. The entire stream of drilling fluid is constrained to enter the upper ports 30 and flow through the venturi and discharge through the lower ports 31 into the annular space 13, by packing off the space 13 at a point intermediate the ports 30 and 31. In the illustrated embodiment, this is accomplished by a packer sleeve 32 seated in a recess 33 in the outer barrel 10 and bridging the annular space between the latter and the sleeve portion 25. Relative rotation between the packer sleeve and the outer barrel is prevented by a lock ring 34 suitably keyed to the barrel and having ratchet teeth 35 projecting upwardly therefrom into interlocking engagement with the packer ring.

From the description thus far, it will be apparent that as the drilling fluid enters the Venturi passage its velocity is increased, due to the reduction in cross-sectional area of the stream, and reaches a maximum velocity in the constricted throat 20; the pressure head is correspondingly reduced as the result of the conversion of pressure head into velocity head. During the passage of the fluid from the throat 20 to the discharge ports 31, the gradual increase in cross-sectional area in the diverging passage 21 reconverts the major portion of the velocity head back to pressure head, and, because of the high efficiency of the Venturi device, the fluid enters the annular space 13 at a restored pressure which depends on the area of the space 13 and substantially unaffected by the temporary pressure drop in the throat 20. Thus, by establishing communication between the interior of the inner barrel 12 and the throat 20, the inner barrel may be vented into the stream of drilling fluid at a pressure materially below that prevailing in the annular space 13 between the inner and outer barrels.

The manner in which the inner barrel is connected to the throat 20 constitutes a salient feature of our invention. An education conduit 40, of relatively small diameter, is mounted in a central bore 41 in the lower section 24 and extends upwardly along the axis of the Venturi passage to a point well above the throat 20. In this form of the invention, its upper extremity is telescoped within a bore 42 in a plug member 43 which in turn has a close sliding fit in a central bore 44 in the upper section 23. The portion of the plug member below the bore 42 is counterbored to form an annular space 45 between the conduit 40 and the depending skirt 46.

The conduit 40 is hollow throughout its length, and at its lower end communicates with a port 48 leading to the interior of the inner barrel 12. A suitable check valve 49 is provided between the port 48 and the inner barrel, to prevent reverse flow of fluid while the inner barrel is being withdrawn to the surface of the well. The valve body also embodies a strainer 50 to exclude solids which might clog the conduit 40. Outlet ports 51 are formed in the conduit 40 above the lower edge of the skirt 46 for the purpose of establishing communication between the conduit and the annular channel 45. It will be observed that the outer wall of the lower portion of the skirt 46 is tapered downwardly, terminating in a relatively sharp lower edge 52. The eduction conduit 40 thus discharges into the throat 20 of the Venturi passage in a direction parallel to the direction of flow of the main stream of drilling fluid, the skirt 46 forming in effect an annular eduction nozzle. The pressure within the annular channel 45 between the skirt 46 and the conduit 40 is thus reduced below that in the throat 20 by an amount equal to the velocity head of the main stream passing through the throat. Inasmuch as the static pressure head of the drilling fluid has al-

ready been substantially reduced at the throat of the venturi, it will be apparent that the total reduction in pressure in the eduction conduit 40 is equal to the combined effect of the Venturi device 16 and the eduction nozzle 46. This pressure drop is sufficient, in actual practice, to more than offset the friction loss in the annular channel 13 and in the discharge passages in the bit, and hence the pressure in the inner barrel 12 is reduced below the external pressure prevailing in the well bore. Resistance to entry of the core into the inner barrel is eliminated, and the core is in many instances actually drawn by suction into the barrel. Cleaner, more complete cores are thus obtained.

Aside from its increased hydraulic efficiency, the device shown in Fig. I is characterized by other features of advantage. It will be observed that the parts defining the Venturi passage are symmetrical with respect to the passage, thus promoting streamline flow through the passage and avoiding eddies and their consequent abrasive effect on the exposed surfaces. The central throat 22, the eduction conduit 40, and the plug member 43, which are subject to the maximum wear, are all readily replaceable and are of simple, inexpensive construction. By separating the threaded connection at 27, the upper and lower section 23 and 24 may be separated, permitting the easy removal and replacement of the three above-mentioned parts.

In Fig. II we have shown a modified form of Venturi device which differs from that illustrated in Fig. I principally by the omission of the skirt 46 from the eduction conduit 40 and the consequent elimination of the eduction nozzle effect of that element. The device comprises upper and lower sections 61 and 62, connected together by an intermediate section 63 permanently secured to the lower section and threadedly connected at 64 to the upper section. The lower section 62 is adapted to be connected to the upper end of a core barrel as in Fig. I. A replaceable throat piece 67, having a constricted throat 67a, is clamped between opposing shoulders 68 and 69 on the upper and lower sections, respectively, and thus may be quickly and easily replaced when the threaded connection 64 is broken.

An eduction conduit 70 is seated at its opposite ends in aligned bores 71 and 72 in the sections 61 and 62, and extends through the throat piece 67 in coaxial relation thereto. The interior of the conduit communicates at its lower end with the inner barrel by way of the passage 73 and preferably through an upwardly opening check valve and a strainer, as in Fig. I. In this embodiment, however, the interior of the conduit 70 communicates directly with the throat 67a through ports 75, which are preferably inclined at a slight downward angle so as to discharge into the main stream of drilling fluid in the general direction of flow of the latter.

The Venturi device of Fig. II functions in a manner similar to that of Fig. I, the pressure within the throat 67a being reduced below that of the drilling fluid above and below the Venturi passage by the conversion of a portion of the pressure head into velocity head in the throat of the passage, and the subsequent reconversion of substantially all of the increased velocity head back to pressure head in the gradually diverging discharge portion 77. This device is incapable of effecting as great a pressure drop in the inner barrel 66 as is the device of Fig. I, in view of the omission of the skirt 46 of the latter figure and its eduction nozzle effect. However, the device of Fig. II possesses the other advantages of the first described form over prior devices—that is, the reduction of abrasive action to a minimum by the symmetrical construction, the simplified and inexpensive construction, and the easy replacement of the eduction conduit and the throat piece.

A still further modification is illustrated in Figs. III and IV. This form of the invention embodies the combined Venturi passage and eduction nozzle of Fig. I, the central eduction conduit being replaced by eduction passages extending upwardly through the wall surrounding the Venturi passage. Upper and lower sections 81 and 82 and an intermediate throat piece 83, having a constricted throat 83a are secured in end-to-end relation by a sleeve 84. The latter is permanently secured to the lower section 82, as by welding at 85, and extends upwardly past the discharge ports 86, around the throat piece 83, past the inlet ports 87, and is threadedly connected to the upper section 81 at 88. The Venturi device is threadedly connected at 89 to the upper end of an inner barrel 90.

In this embodiment of the invention a modified arrangement is provided for connecting the interior of the inner barrel in communication with the throat of the Venturi passage. Extending upwardly within the lower section 82 from the usual check valve and strainer body 92 is a central passage 93, which terminates at its upper end within the body of the section 82. A pair of diametrically opposite branch passages 94 and 95 (Fig. IV) extend upwardly and outwardly from the central passage 93 to the outer periphery of the section, and communicate with longitudinal passages 96 and 97, respectively, extending upwardly along opposite sides of the Venturi passage, in an axial plane at right angles to the axial plane intersecting the inlet and discharge ports 87 and 86. For purpose of illustration, we have shown the passages 96 and 97 as formed by aligned channels in the outer peripheries of the lower section 82, throat piece 83, and upper section 81. It will be understood, however, that if desired the passages may instead be formed by channels cut in the inner wall of the sleeve 84.

At the upper extremities of the passages 90 and 97 a second pair of branch passages 98 and 99 extend upwardly and inwardly to a central passage 100 formed in the upper section 81. The passage 100 is closed at its upper end and is threaded at its lower end to receive the upper threaded end of an eduction nozzle member 101, which extends downwardly along the axis of the Venturi passage to a point adjacent the throat 83a. The lower portion of the nozzle member 101 is tapered downwardly and terminates in a relatively thin edge at 102, to avoid an abrupt change in cross sectional area of the fluid stream at that point.

From the foregoing description of this modification, it will be apparent that the inner barrel 90 is vented to the throat 83a through the passages 93, 94, 95, 96, 97, 98, 99 and 100, and the nozzle member 101, and that the pressure within the member 101 will be lower than the pressure of the drilling fluid at the discharge port 86 by an amount equal to the combined pressure drop effected by the Venturi passage and the eduction nozzle. This form of the invention is slightly more complicated than the other two forms from a manufacturing standpoint, but is more effective in reducing the pressure in the inner barrel.

This is because of the elimination of the central eduction conduit extending through the Venturi passage, thus making it possible to achieve the maximum suction effect on the open end of the eduction nozzle 101.

In Fig. V we have shown a slightly modified form of the embodiment illustrated in Fig. I, the modifications being only those necessary to adapt the device of Fig. I to use in conjunction with a conventional core barrel. The term "conventional core barrel" is commonly used to denote a well coring assembly in which the inner, core-receiving barrel is secured within the outer barrel and is lowered into the well and removed therefrom with the outer barrel, in contradistinction to a "wire line" assembly such as shown in Fig. 1. A spearhead is not required on the inner barrel of a conventional core barrel assembly, and hence the upper section 23 and its lateral inlet ports 30 of Fig. I may be dispensed with, thus providing an unobstructed central fluid passageway leading downwardly to the Venturi device.

In the modified Venturi device shown in Fig. V, a lower section 110 is suitably secured at its lower end to the upper end of an inner barrel (not shown) and is threadedly connected at its upper end to a sleeve member 111. The latter is permanently secured, as by welding at 112, to the lower end of an upper section 113. A throat piece 114 is detachably clamped between opposing shoulders 115 and 116 on the upper and lower sections, respectively, and has a constricted throat 117 intermediate its ends. Below the throat 117, a diverging discharge passage 118 extends downwardly to lateral discharge ports 119 in the lower section. An eduction conduit 120 is mounted in the lower section and extends upwardly along the axis of the Venturi passage to a point well above the throat 117. Mounted on the upper extremity of the conduit is a plug member 121 having a bore 122 to receive the conduit and a counterbore 123 forming a depending skirt portion 124 spaced from the conduit by an annular channel 125. Suitable outlet ports 126 are formed in the wall of the conduit in the upper portion of the counterbore, whereby fluid passing upwardly within the conduit is discharged into the channel 125 and thence into the throat 117 in the direction of flow of drilling fluid through the Venturi passage. The interior of the conduit communicates with the inner barrel in a manner similar to that shown in Fig. I.

Thus far the device is in all respects similar to the device of Fig. I. The upper section 113, however, merges upwardly into an annular tube 130 which is open at its upper end and is mounted centrally within the outer barrel 131 to present a central, unobstructed passage leading to the Venturi passage. The eduction conduit 120 in this instance is supported only at its lower end in the lower section 110, and the upper extremity of the plug member 121 converges upwardly, as shown at 132, in order to provide streamline flow of drilling fluid from the central passage into the annular Venturi passage.

All of the advantages of the device of Fig. I are also inherent in the modified device shown in Fig. V, including the combined pressure reduction resulting from the Venturi passage and the eduction nozzle effect of the annular discharge channel 25. The parts which are subject to the most wear are easily replaceable and are of simple and inexpensive construction.

Although we have shown and described in detail several specific forms which the invention may assume, it is to be understood that the invention is not limited to the details of construction shown therein, but is of the full scope of the appended claims.

We claim:

1. A device for use in combination with a core drill of the type having an outer barrel secured to the lower end of a drill stem and a core barrel mounted within the outer barrel, comprising: an elongated body mounted on the upper portion of the core barrel and having a Venturi passage formed therein in the path of drilling fluid in said drill stem; and means communicating said bore barrel with the throat of said Venturi passage, comprising an eduction conduit extending coaxially within the Venturi passage and having communication at one end with the interior of the core barrel and having an opening at the throat of the Venturi passage.

2. A device for use in combination with a core drill having an outer barrel connected to the lower end of a drill stem and an inner core barrel mounted within the outer barrel, comprising: an elongated body mounted on the upper portion of the inner barrel and having a passage therein in the path of drilling fluid circulated downwardly through the drill stem, said passage including a restricted throat portion and a gradually diverging portion on the downstream side of the throat portion; and means establishing communication between the inner barrel and said restricted throat portion comprising a conduit member mounted in said body and extending into said passage in coaxial relation thereto and opening into the throat portion thereof, and passage means connecting said conduit member with the interior of the inner barrel.

3. A core barrel venting device for core drills, comprising: a lower body member adapted to be mounted on the upper portion of a core barrel and having a central opening therein and a discharge port leading therefrom; an upper body member mounted above said lower body member and having an inlet port and a central opening therein; an intermediate member mounted between said body members and having a central opening including a restricted throat portion; means detachably securing said body members and said intermediate member together with their openings in alignment to form a passage extending from said inlet port to said discharge port; and means communicating said core barrel with the throat portion of said intermediate member, comprising a conduit member extending coaxially within said passage and having an opening therein communicating with said throat portion, and passage means connecting said conduit member with the interior of the core barrel.

4. A core barrel venting device as set forth in claim 3, in which said conduit member is supported at opposite ends thereof by said body members.

5. A core barrel venting device as set forth in claim 3, in which said conduit member is detachably mounted at opposite ends thereof in said body members and is held therein solely by the means detachably securing said body members together.

6. A core barrel venting device as set forth in claim 3, in which said intermediate member is clamped between opposing shoulders on said body members.

7. A core barrel venting device as set forth in claim 3, in which said means for detachably se-

curing said body members and said intermediate member together comprises a sleeve member surrounding said intermediate member and connected at opposite ends to said body members, at least one of said connections being readily releasable.

8. In a core barrel venting device for core drills, means for relieving the core barrel of the pressure of the drilling fluid circulated past said venting device, comprising: a body member mounted on the upper portion of the core barrel and having a Venturi passage formed therein in the path of the drilling fluid; an eduction conduit mounted in said Venturi passage and having an outlet disposed in the restricted throat thereof and facing in the direction of flow of drilling fluid through the passage; and passage means connecting the inlet end of the eduction conduit with the interior of the core barrel.

9. In a device of the character described, the combination of a body adapted to be mounted on the upper portion of a core barrel and having a Venturi passage formed therein, an eduction nozzle member mounted in the converging portion of the Venturi passage in coaxial relation thereto and with its outlet end disposed at the throat of the passage and facing the discharge end of the passage, and passage means communicating the inlet end of the eduction nozzle member with the interior of the core barrel.

10. A device as set forth in claim 9, in which said passage means comprises conduit means extending from the core barrel coaxially through said Venturi passage and telescopically within said eduction nozzle member, and having an outlet communicating with said nozzle member.

11. A device as set forth in claim 9, in which said passage means is defined by walls extending through said body from the core barrel to the remote end of said Venturi passage.

12. In a device of the character described, the combination of a body adapted to be mounted on the upper portion of a core barrel and having a Venturi passage formed therein, said body having aligned bores at opposite ends of said Venturi passage and coaxial therewith, passage means communicating one of said bores with the interior of said core barrel, an eduction conduit mounted in the other bore and having an outlet at the throat of the Venturi passage, and passage means connecting the inlet end of said eduction conduit with the first-named bore.

13. In a device of the character described, the combination of a body adapted to be mounted on the upper portion of a core barrel and having a Venturi passage formed therein, said body comprising separable sections detachably secured together and having opposed sockets therein at opposite ends of and coaxial with said Venturi passage, a conduit member having its ends mounted in said sockets and extending coaxially through said Venturi passage, said conduit member having an outlet communicating with the throat of the Venturi passage and an inlet communicating with the interior of the core barrel.

14. A device as set forth in claim 13, in which said conduit member includes a skirt surrounding said outlet and terminating at the Venturi throat, said skirt being spaced from the conduit member to form an annular channel therebetween extending from the outlet to the Venturi throat and facing in the direction of fluid flow through the throat.

15. In a device of the character described, the combination of a body adapted to be mounted on the upper portion of a core barrel and having a Venturi passage formed therein, said body comprising separable sections detachably secured together and having opposed sockets therein at opposite ends of and coaxial with said Venturi passage, passage means connecting said core barrel with the adjacent one of said sockets, a plug member having one end thereof mounted in the other socket and having an axial bore extending from the other end at least partially therethrough, a conduit member having one end thereof mounted in said first-named socket and having its other end mounted in the bore in said plug member, said conduit member having a lateral outlet adjacent said other end, and said plug member having a skirt surrounding said outlet.

16. A device as set forth in claim 9, in which said body is provided with a centrally disposed inlet and an axial fluid passageway leading from the inlet to the Venturi passage, and in which said eduction nozzle member includes a closed upper end disposed coaxially within the fluid passageway and tapered upwardly to divert the fluid into the Venturi passage with a minimum of disturbance.

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CERTIFICATE OF CORRECTION.

Patent No. 2,329,225. September 14, 1943.

LEONARD L. SNYDER, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 39, for "effort" read --effect--; line 42, and page 2, second column, line 38, for "education" read --eduction--; page 3, first column, line 24, for "throat 22" read --throat piece 22--; and second column, line 49, for "passages 90" read --passages 96--; page 4, first column, line 72, for "channel 25" read --channel 125--; and second column, line 14, claim 1, for "bore" read --core--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of November, A. D. 1943.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)