

Feb. 12, 1963

I. COSTA

3,077,358

WELL-DRILLING PIPE

Filed Aug. 26, 1959

3 Sheets-Sheet 1

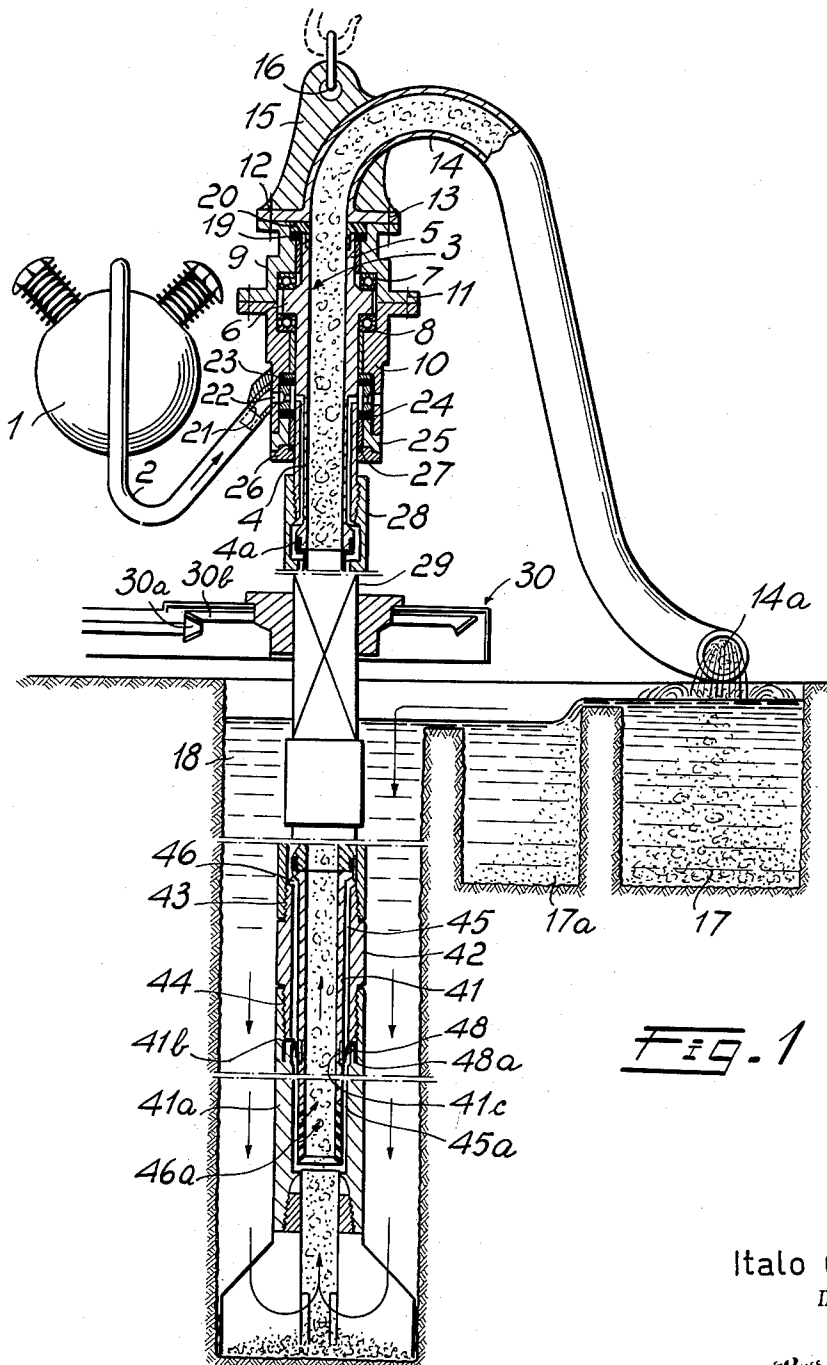


FIG. 1

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3 Sheets-Sheet 2

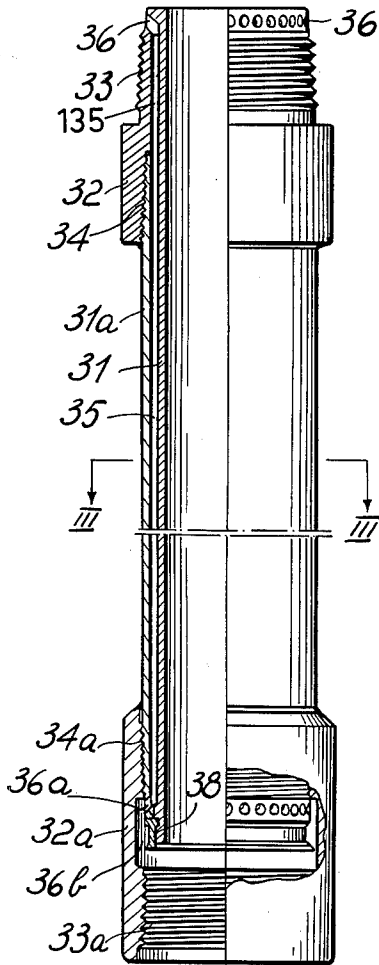


Fig. 2

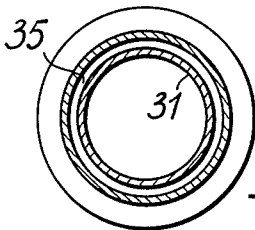


Fig. 3

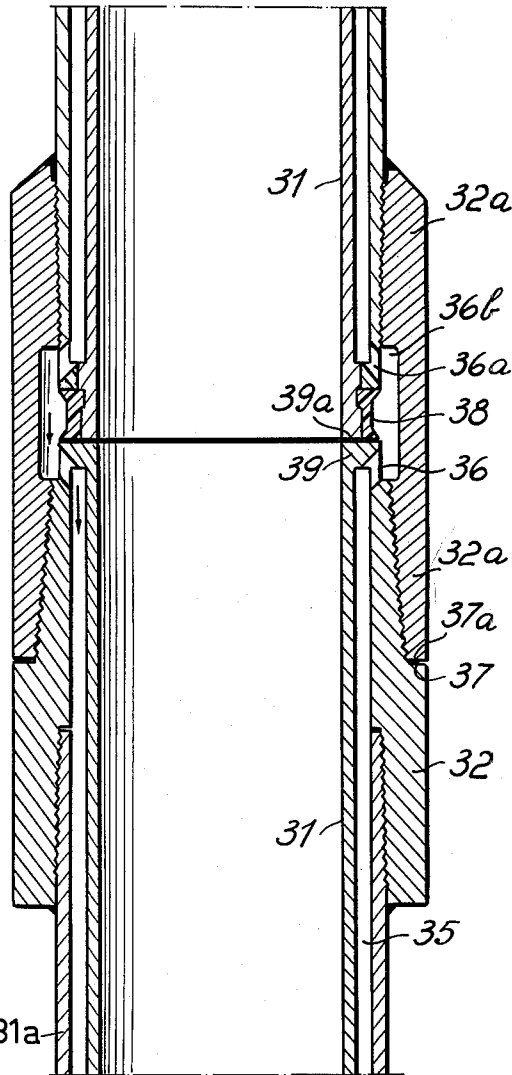


Fig. 4

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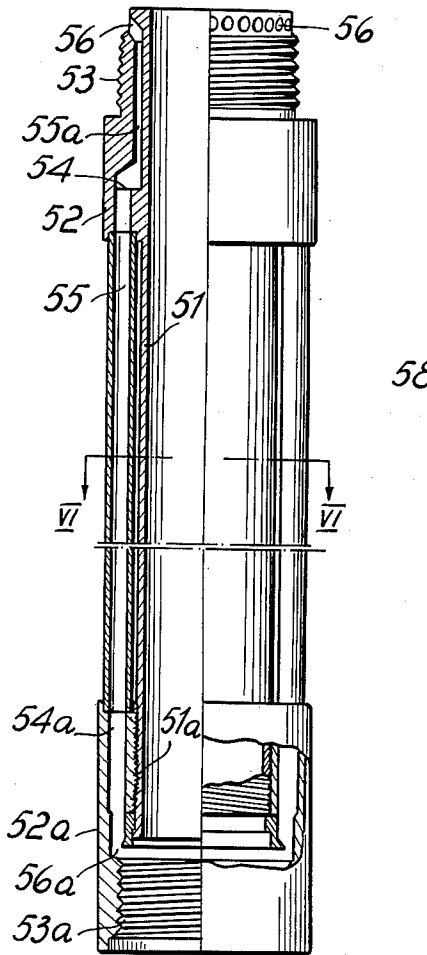


Fig. 5

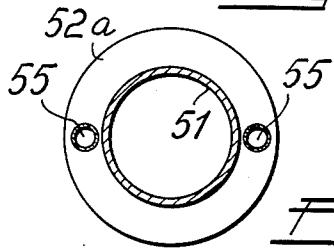


Fig. 6

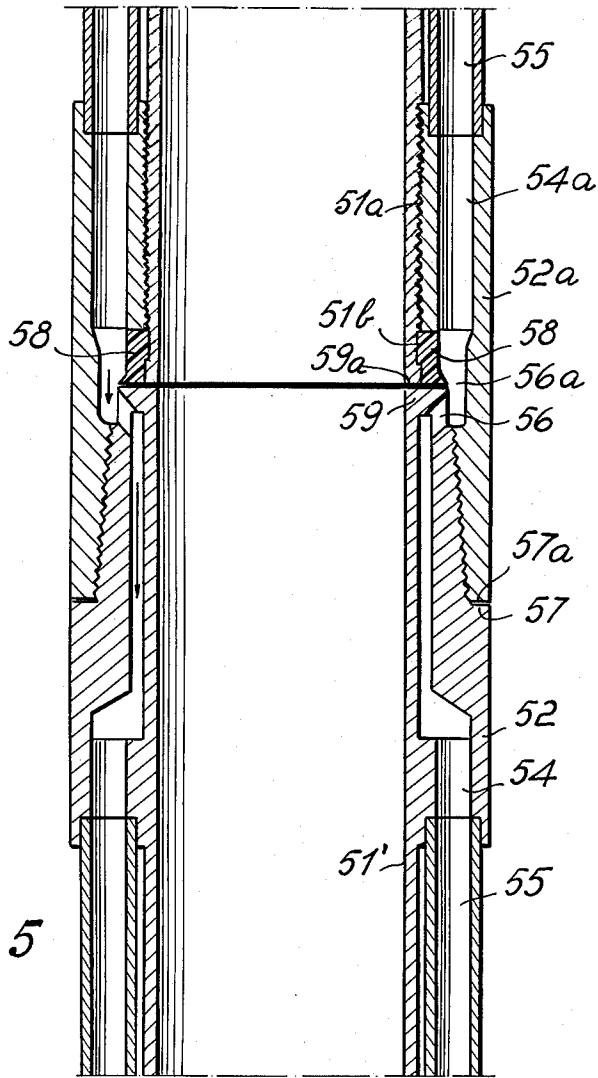


Fig. 7

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3,077,358

WELL-DRILLING PIPE

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Filed Aug. 26, 1959, Ser. No. 836,111

Claims priority, application Italy Sept. 18, 1958

5 Claims. (Cl. 285—133)

This invention relates to a pipe string for an aerated-mud drilling apparatus composed of generally elongated tubular members which are axially interconnected and constitute means for conducting compressed air necessary to lift detritus during the drilling operation.

The rotary drilling method is well known. In it the boring rods serve not only to transmit rotary movement to the bit but also to provide a passage for the descending liquid (drilling sludge) which is urged, by an appropriate pump, through the tubular boring rods towards the drilling bit to wash and clean the bit and, during the ascent of the sludge towards the ground level, to entrain therewith the detritus of the drilling operation through the annular clearance between the rods and the drilled well. This is possible by reason of the low ascent rate and the high viscosity, density and specific weight of the pumped liquid, all of which are factors contributing to hold the detritus in suspension. Such detritus should therefore be composed only of very small fragments, hence considerable fragmentation work must be done by the boring tool which in turn slows the progress of the drilling operation.

Moreover, since in a rotary drilling system the liquid circulates in a closed path, and owing to the viscosity and density characteristics of the liquid, it is never possible to carry out a completely satisfactory decantation so that the circulating liquid is always dirty with sludge and has a limited lifting capacity which results in considerable wear of the working members of the pump.

To eliminate these drawbacks at least partially, pipe sections with a reverse circulation of the liquid have been proposed in which compressed air is used as an auxiliary means for lifting the detritus, or use is made of suction pumps. Such tubular devices do not allow either a simple and efficient handling of the drilling apparatus or the rapid establishment of an air-tight connection of the pipe sections to one another and to the auxiliary means for circulating the compressed air.

An object of the invention is to provide a drilling rod or string of the kind described in which the handling of the drilling apparatus is as simple and efficient as that of the boring rods of conventional rotary systems, thus eliminating useless time losses during the axial interconnection of the constituent pipe sections and insuring a perfect seal for the compressed air which has to circulate within those sections. Another object of the invention is to provide a reverse-circulation drilling string having a constant inner cross-sectional area throughout its length in order to improve and facilitate the flow of the detritus therethrough, especially in cases where the detritus consists of particles the size of pebble gravel.

A further object of the invention is to provide such a device in which the pipe sections may be easily coupled not only to one another but also to an emulsifier end member, thus making it possible to bring the compressed air up to a desired depth so as to regulate at will the column height of the emulsifiable liquid and thereby to control the speed of the liquid within the rods as well as the flow rate thereof.

These and other objects of the invention are attained by a well-drilling pipe according to the invention which comprises a plurality of pipe sections, in the form of abuttingly interconnected inner tubular member, pro-

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vided with channel-forming conduit means consisting of one or more external tubes for conducting a pressure fluid independently of the central bores of these members. Each inner tubular member of the device terminates at one end in a connector having an external male thread and at the other end in a connector having an internal female thread complementary to said male thread. One of the connectors, more specifically the female one, extends beyond its pipe section and has a recessed wall at the level of the joint between abutting pipe ends so as to define clearances bridging these ends and communicating with the aforementioned conduit means for establishing a continuous flow path for the fluid under pressure, this flow path being tightly sealed against the atmosphere and also against the central bores of the pipe sections.

The invention will now be more fully described with reference to some illustrative embodiments thereof represented in the accompanying drawing in which:

FIG. 1 is a diagrammatic view of an entire rotary drilling plant with reversed flow, the major part thereof being shown in section;

FIG. 2 shows, partially in axial section, a drill-pipe section according to a first embodiment of the invention;

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

FIG. 4 shows, in a cross-sectional view drawn to an enlarged scale, two interconnecting pipe sections of the type shown in FIGS. 2 and 3;

FIG. 5 is a view similar to FIG. 2, showing a second embodiment of the invention;

FIG. 6 is a cross-sectional view taken along line VI—VI of FIG. 5; and

FIG. 7 shows an enlarged axial section of the interconnected end portions of two coupled pipe sections of the type illustrated in FIGS. 5 and 6.

As shown in FIG. 1, the novel reverse-flow drilling plant according to this invention comprises an air compressor 1 which, through a hose 2, drives pressurized air into an axially extending passage 4 in a rotatable head indicated generally at 3. More particularly, the head comprises a tubular body 5 of the usual type which is rotatably supported by means of its collar 6 within bearings 7 and 8, the axial passage 4 being located within the tubular body 5 below collar 6. The bearings 7 and 8 are in turn supported on an external unit composed of two sleeves 9 and 10 which are bolted together at 11 and of which the upper sleeve 9 is in turn fixed by means of bolts 12 on the flange 13; the latter constitutes the end portion of a discharge duct 14 and carries a plate 15 having a bore 16 for connecting it with a suspension hook. The duct 14 terminates with its free end 14a in the proximity of decantation tanks 17, 17a into which the drilling mud is discharged; this mud overflows into the well 18 and coats its walls until it reaches the zone of the drilling tool at the bottom of the well. Gaskets 19 and 20 are inserted at the junctions between the flange 13, the upper part of the sleeve 10 and the upper part of the tubular body 5. The inlet hose 2 is connected to the boss 21 which communicates with a passage 4 through an orifice 22 provided within the lower sleeve 10. The connection represents a hermetic seal by virtue of stuffing-box packings 23 and 24 held clamped by a ring nut 25 which matingly engages the lower internal screw threads provided on the sleeve 10, while another ring nut 26 clamps a further packing 27 against the tubular body 5 and against the ring nut 25. The air, which thus enters in a hermetical manner the passage 4, reaches an annular recess 4a, provided in a connecting sleeve 28 which will be described hereinafter, and then passes through suitable axial channels within a square rod 29 of a type known per se (e.g. from U.S.

Patent No. 2,849,213) and commonly referred to as "Kelly" rod. The square rod 29 is driven by a turntable 30 and by the engagement between a driven pinion 30a and the bevel-rim gear wheel 30b. The rod 29 is connected by means of sleeve joints with the system of tubular pipe sections which are better illustrated in FIGS. 2, 3 and 4.

As shown in these figures, each pipe section comprises a tubular member 31 and a surrounding sleeve 31a forming therewith an axially extending annular channel 35. The top end of the sleeve 31a carries screw threads 34 engaging a male connector 32 which is provided at its upper part with male screw threads 33 of the rapid-pitch type, the connector 32 forming an extension 135 of channel 35 terminating in radial apertures 36. The connector 32 is integral with the internal tubular member 31. At its lower end the sleeve 31a terminates in screw threads 34a engaged by a female connector 32a which is independent of the tubular member 31 and is internally provided with female screw threads 33a of the rapid-pitch type complementary to the male screw threads 33. The sleeve 31a is further provided, at its lower end, with apertures 36a which open into the annular clearance 36b between a recessed wall portion of connector 32a and the lower end 39a of the member 31, this lower end constituting an annular seat for a packing 38.

As best seen in FIG. 4, the coupling of two pipe sections of the type illustrated in FIG. 1 is accomplished in that the male screw threads 33 are screwed onto the female screw threads 33a of a preceding element, the packing 38 providing a perfectly tight internal seal for the central bore of the tubular member 31, at the zone where the end 39a contacts the end 39 of the preceding member 31, while a tight closure towards the outside is obtained by means of a metallic contact between terminal end 37a of the sleeve 32a and shoulder 37 formed by the sleeve 32.

The novel pipe sections not only allow a rapid end-to-end coupling of their tubular members with each other, but further provide a hermetic connection without discontinuity between the walls of the central bores of adjoining members 31. Moreover, a similar hermetic connection exists between the annular channels 35 of these members.

Advantageously, a drilling-pipe system of the above-described type is associated with a terminal emulsifier which may be readily and efficiently coupled to the downstream end, as seen in the direction of compressed-air flow, of any of the members 31. This emulsifier comprises a tubular member 41 having an internal diameter corresponding to that of the tubular member 31 to which it may be selectively coupled, with the aid of a male connector 42 generally similar to the aforedescribed connector 32, for use at any desired depth within the well 18. At its lower end the connector 42 is formed with external screw threads 44 engaged by a sleeve 41a which has a shoulder 41b forming together with the end of the thread 44 an axially extending groove to receive an annular flange 48a of a special packing 48; this packing has an axial section in the form of an inverted V whose inner arm tends to diverge from the outer arm constituting the flange 48a so as permanently to contact a ferrule 41b which is externally slipped on the pipe 41. The packing 48 is disposed, with the vertex of the V facing in the upstream direction, in an annular channel 45 formed by the connector 42 which spacedly and concentrically surrounds the member 41; channel 45 terminates at the top in radial apertures 46 and merges at the bottom with a channel 45a defined by the inner wall of sleeve 41a and by the outer wall of the pipe member 41. The packing 48 thus disrupts the connection between the channel 45 and its extension 45a, but this barrier is elastically yieldable since the compressed air above the packing bends the free inner arm of the V and may therefore flow past it while the air beneath the

packing is prevented from passing in the upward direction, thereby checking the return flow. The packing ring 48 thus constitutes an annular check valve serving to prevent the entrance of the drilling liquid (mud) into the channel 45a—45, and consequently into the channel 35, thus maintaining the air passages perfectly clean.

When the air has passed beyond the packing 48 it enters through the emulsifying bores 46a, according to the arrows of FIG. 1, into the central bore of tubular member 41, thereby emulsifying the drilling mud to reduce its density to much less than that of the mud within the well.

The pipe sections may of course be modified in various ways within the scope of this invention. Thus it is possible to provide, instead of continuous annular channels extending between two coaxial and concentric tubular bodies for forming a passage for the pressurized air, external pipes for conducting the air along external passages parallel to the main tubular member of each pipe section of the rotary drilling system. An embodiment of this kind will now be described with reference to FIGS. 5, 6 and 7 which show a pipe section comprising an internal pipe 51 provided at its upper end with an external connector 52, integral with pipe 51, having male screw threads 53 of the rapid-pitch type and an annular channel 55a whose upper end opens toward the outside through radial apertures 56 and whose lower end forms a passage 54 communicating with a narrow pipe 55 extending externally of and parallel to the wider pipe 51. In practice at least several pipes 55 are provided, only two being shown in FIGS. 5, 6 and 7 in diametrically opposite positions.

The pipe 51 ends at its bottom in a screw thread 51a onto which a sleeve 52a is screwed to serve as a female connector; this sleeve has at its lower end, projecting beyond the pipe 51, female screw threads 53a of the rapid-pitch type and is formed in the region surrounding the pipe 51 with passages 54a for connecting the external pipes 55 with an annular clearance 56a surrounding the joint between pipe sections 51, 51'. Within an annular groove 51b of pipe 51 there is disposed a packing 58.

In this embodiment, the coupling of adjoining pipe sections is realized in the manner illustrated in FIG. 7, i.e. with the threads 53 of male connector 52 screwed into the threads 53a of female connector 52a so that the end 59a of the pipe 51 bearing the packing 58 contacts the opposite end 59 of the next-lower pipe 51', the packing being compressed therebetween and effecting a hermetic seal towards the central bores of the pipe sections for the air which is circulating within the channel 54a, 55 while a similar seal towards the outside is obtained by the metal-to-metal contact between the end 57a of connector 52a and the shoulder 57 of connector 52.

As may be seen from the above description, the tubular members of the interconnected pipe sections are of compact construction and have central bores of constant cross-sectional area so that the flow of the detritus will be facilitated within the interior of these pipes even if its constituents include particles of a great size.

Consequently, since the pipe sections according to the invention allow big and heavy soil fragments to be brought to the surface level, it is possible to carry out the drilling at high forward speed whereby the tool needs to perform only the drilling work proper and no grinding work.

Furthermore it is possible to execute a more rapid and exact evaluation of the drilled strata as compared with the fragments obtained by known devices. The rapidity of the evaluation is due to the great quantity of the circulating liquid and its exactitude is insured by the fact that the detritus arrives on the surface level in such a quantity and concentration as to be readily classifiable even when consisting of small particles, as in the case of sand of very fine granular structure, or when of an argillaceous nature, in which case it will come to the

surface in the form of large chunks whose composition has remained unchanged in the process.

Another advantage of the reverse-flow rotary drilling system according to the invention is that it enables the circulation of a liquid whose viscosity, density and specific weight are remarkably lower than those of liquids used in conventional rotary drilling systems, whereby a more efficient and rapid discharge of the detritus is possible. Thus, a clean liquid free from sludge may be introduced into the clearance between the rods and the drilled well to help eliminate the binding of the drilling apparatus within the well, normally due to the sedimentation of the detritus within the aforementioned clearance.

The invention is not limited to the embodiments described but various modifications and variations are possible within the scope of the invention as defined in the appended claims.

What is claimed is:

1. A well-drilling pipe string comprising a plurality of substantially equal-diameter pipe sections disposed with communicating central bores in end-to-end abutting relationship, a first connector secured to one end of each pipe section and projecting radially therefrom, said first connector being provided in its projecting part with an axially extending throughgoing channel isolated from the central bore of its pipe section, a second connector secured to the opposite end of each pipe section and projecting radially therefrom, said connectors being provided with complementary screw threads matingly engaging each other at abutting ends of adjoining pipe sections for holding the latter together, said second connector extending axially beyond its pipe section and having a recessed inner wall at the level of said abutting ends whereby a clearance bridging said ends is formed, and conduit means held in position alongside each pipe section by the two connectors thereof, said conduit means extending from said recess to said channel and communicating therewith for establishing a continuous flow path independent of said central bores alongside said pipe sections.

2. A well-drilling pipe string comprising a plurality of substantially equal-diameter pipe sections disposed with communicating central bores in end-to-end abutting relationship, a male connector secured to one end of each pipe section and projecting radially therefrom, said male connector being provided in its projecting part with an

axially extending throughgoing channel isolated from the central bore of its pipe section, a female connector secured to the opposite end of each pipe section and projecting radially therefrom, said connectors being provided with complementary screw threads matingly engaging each other at abutting ends of adjoining pipe sections for holding the latter together, said female connector extending axially beyond its pipe section and having a recessed inner wall at the level of said abutting ends whereby a clearance bridging said ends is formed, and conduit means held in position alongside each pipe section by the two connectors thereof, said conduit means extending from said recess to said channel and communicating therewith for establishing a continuous flow path independent of said central bores alongside said pipe sections.

3. A pipe string according to claim 2 wherein said conduit means comprises a sleeve surrounding the respective pipe section with concentric spacing, said sleeve being threadedly secured to both said connectors.

4. A pipe string according to claim 2 wherein said conduit means comprises a set of tubes parallel to the respective pipe section and of reduced cross-sectional area relative thereto.

5. A pipe string according to claim 2 wherein said male connector is integral with its pipe section.

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