DOUBLE-DISHED PIPELINE PIG

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ABSTRACT

A pipeline pig having a dished face at each end, the dished face improving the wiping action of the periphery of the pig as it passes through the pipeline, there being a slightly compressible axial member cast internally of the pig extending from the dished face at one end to the dished face at the other end to protect the pig against pressure surges which tend to rupture the pig in transit in the pipeline. The invention also relates to a method of forming for such pigs.

10 Claims, 9 Drawing Figures
DOUBLE-DISHED PIPELINE PIG

SUMMARY OF PROBLEM AND INVENTION

Pipeline pigs have been provided heretofore with bullet-shaped noses, dished faces, and the like. In many circumstances, a dished face has been found preferable for a pipeline pig. Pipeline pigs have been attempted heretofore with a dished face at both ends, but the gripping action of such pigs is sometimes too good. A surge of pressure traveling in the pipeline acts somewhat as a shock wave. When the shock wave hits the pig and the pig firmly grips the side walls, the shock wave must be absorbed in the pig. Quite often, pigs have simply disintegrated on the passage of a shock wave. The disintegration has given rise to problems making the double-dished pig essentially unworkable, which has essentially led to its abandonment.

The apparatus of the present invention provides an improved double-dished pipeline pig which obviates the problem mentioned above. The pig is preferably formed with a dished face at each end, and includes an outer shell contiguous with the dished faces on both ends of a relatively hard plastic material. However, the central portions of the pig are communicated by means of ports, or even microscopic open cell structures to permit pressure equalization within the pig with pressures in the pipeline. Additionally, the central portions are formed of a resilient material except that an axial portion of substantially increased strength extends between the dished faces to prevent the dished face at either end from giving excessively on the occurrence of the pressure surge.

Further, a method of manufacture permits fabrication of a pig having an exterior of hardened particles to improve the cleaning action and extend the life of the pig.

The foregoing summarizes the present invention. The following written specification sets forth the details of construction in conjunction with the drawings, which are:

FIG. 1 is a perspective view of the pig of the present invention in a pipeline;
FIG. 2 shows the method of the present invention and a molding technique for forming the pig, which includes double-dished ends;
FIG. 3 is a sectional view of the completed pig manufactured in accordance with the method shown in FIG. 2;
FIG. 4 discloses an alternative embodiment having an increased number of edges for wiping the pipe bore;
FIG. 5 shows the pig of FIG. 4 in a mold which forms additional edges on the pig while casting a fairly tough outer shell about a foamed insert positioned in the mold;
FIG. 6 shows a sectional view through the mold and illustrates a number of openings which communicate the interior of the pig with the pipe line;
FIG. 7 is a side view of an alternative embodiment including spiral grooves which cause the pig to rotate as it traverses a pipeline, evenly distributing the wear;
FIG. 8 is a sectional view of the pig of FIG. 7 showing a method of manufacture therefor; and,
FIG. 9 is a sectional view through the pig showing its hardened external surface.

In the drawings, the numeral 10 indicates a pipeline in which the pig 12 of the present invention is located.

The pig 12 is a double-dished pipeline pig which has a concave face at each end. Preferably, it is cylindrical and its diameter is approximately equal to the nominal i.d. of the pipeline 10. The pig is forced through the pipeline 10 by the pressure fluid flowing in the pipeline. The pig is used to clean deposits from the walls of the pipeline, to force an accumulation of liquid out of low spots in a gas pipeline, or the like. Pigs are customarily forced through the pipeline at selected occasions for the cleaning and remedial purposes mentioned above.

Considering the invention in greater detail, it will be best to first describe the method of manufacture, and then the completed pig. For this purpose, attention is first directed to FIG. 2 which shows a mold indicated by the numeral 14. The mold 14 has an internal configuration which forms the external surface of the pig 12 when manufactured. A pour hole 16 is formed at the upper end of the mold. The internal wall 18 forms a cylinder and the lower wall 20 forms a cone face. The upper wall 22 is similar to the wall 20 and the two walls define the concave faces desired on the completed pig. The angle of the cone is not extreme, but can be something in the range of 5° to 15°, depending on a number of factors. The diameter of the mold 14 is likewise matched to the i.d. of the pipeline with the goal of having the cylindrical face of the pig wipe the bore of the pipeline clean.

In FIG. 2, a pair of support pins 24 and 26 extend inwardly of the cylindrical open space to support a core member 28. The core member 28 is preferably formed of a relatively soft, low density polyurethane material and is held in position by the pins 24 and 26. The density is in the range of 10 to 30 pounds per cubic foot. The core member includes an axial opening for reasons to be discussed. The core member 28 is spaced from the cylindrical wall 18 and from the dished face ends of the mold at 20 and 22 an appropriate distance to permit the completed pig, on pouring of the harder material to be described, to attain a wall thickness which is adequate for the hard use and wear which the pig encounters in the pipeline. Briefly, the wall thickness is in the range of perhaps a half inch or so adjacent to the core surrounded by an external thickness of the molded portion of the pig 12. The dished faces on the ends of the completed pig are preferably thicker, in the range of one-half to three-fourths inch thick.

A higher density polyurethane material is utilized to form the shell surrounding the core member 28. Preferably, a polyurethane material having about 70 durometer hardness is used. Thus, the cured pig has a complete exterior of this hardness, and yet the pig as a whole is somewhat flexible inasmuch as the core member, a relatively low density yieldable material, permits the required degree of flexure for the pig to permit it to travel through the pipeline. More particularly, the pig, when completed, is encased in the harder material to substantially increase its life during usage.

The molding operation begins with the central core 28 in the posture shown in FIG. 2. The heavier material is gently poured into the mold and it fills the mold from the bottom up, including those portions of space outside the core and adjacent to the cylindrical wall 18 and also up the central axis of the core member 28. Additionally, the poured material fills both dishes, that is, the dished face spaces at the top and the bottom, to complete the pig. The material is poured until the mold
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is filled and the pourhole 16 gives evidence of this fact. Preferably, the pourhole 16 should be of sufficient diameter to permit the escape of air bubbles while pouring.

It will be observed that a unitary pig is formed with a double-dished face at each end. Those engaged in pig manufacture have had difficulties in forming double-dished pigs inasmuch as there is a tendency, on molding, to trap bubbles in one of the concave faces. This problem has greatly reduced the quality of pigs formed to date. Consequently, the prior art has been found wanting in the provision of a means or method for the manufacture of an integrally formed pig having two concave faces.

The completed pig is shown in FIG. 3. In FIG. 3, the numeral 32 indicates the structural material at one end of the pig. Attention should be carefully directed to this face for an understanding of the heavy gauge of high density polyurethane foam which forms the end face. There is enough structure for the pig to bear up under the stress and strain of its intended application, and yet enough flexibility to permit it to give on pressure surges. Moreover, the pig is somewhat flexible and incorporates an outer lip at the dished face which grips and wipes against the bore of the pipeline. It will be understood and appreciated that this is a valuable action inasmuch as the pig is quite often used to wipe rather slippery materials such as paraffin coatings from the walls of the pipeline.

The pig as shown in FIG. 3 further incorporates a central support or structural member 34 which extends from one face to the other. On the occurrence of a pressure shock, the member 34 supports both faces at a spaced location without unduly flexing or giving. It is not so rigid that it causes the pig to rupture and break into small pieces on a pressure surge. On the other hand, the axial structure member 34 which is integrally formed with the two dished faces is not so yieldable or pliable as to permit the pig to deform unduly. It will be understood that if the member 34 unduly elongates, the pig would shrink in diameter and would not have the desired contact with the full periphery of the bore of the pipeline.

It will be noted that the core member 28 is left essentially intact within the body of the pig 12 as shown in FIG. 3. Moreover, the pins 24 and 26 are pulled from the cast polyurethane structure. A number of pressure relief openings 40 are drilled in the side wall of the pig to the soft inner core member 28. It should be understood that the drilled holes are helpful in providing pressure equalization within the body of the pig. For this reason, the ports or openings 40 found at random around the circumference of the cylindrical pig relieve the pressure from within the pig and permit the pig to equalize with the pipeline pressure. In the alternative, an open celled foamed polyurethane can be used to permit the pressure fluid to pass through the side walls of the cylinder and communicate with the internal portions of the pig. Open cell polyurethane casting is believed well known in the art.

The holes or openings 40 are preferably drilled at the convenience of the user, and there is no set pattern or required number of openings except that they be sufficient in number to provide the fluid communication and yet not be so great in number as to weaken the physical structure of the pig.

Attention is next directed to FIGS. 4, 5 and 6 which illustrate a pig embodiment identified by the number 62. The pig 62 is similar to the pig 12 in most regards except that the pig 62 is circumferentially slotted at three or four locations at a point near its middle. The pig 62 is improved over the pig 12 in one or two significant regards. The first is that the pig 62 has more wiping edges or lips for removing paraffin coatings in the pipeline. Moreover, the pig 62 is able to flex. On negotiating a curved pipe, the grooves or slots take up axial bending or flexure. The most extreme bend is about one times the radius of the pipe while many bends are about three times the radius. It is axiomatic that a pig in the pipeline must negotiate any curve or bend which it encounters. As a consequence of the grooves or slots, the pig 62 is able to traverse the curves.

As shown in FIG. 5, the same internal core 78 is placed in a mold 64. The mold is filled with the liquid urethane polymer which is cured to a desired hardness depending on formulation. The finished product is shown in FIG. 6 where the pig includes the opposing dished ends connected by an axial rod or support 84. Of particular interest, FIG. 6 discloses details of the slots or grooves in the pig 62. There are three in number, but two or four may be used for various sizes. The foamed core is communicated with the exterior through a number of passages at 90. The passages open to the exterior at the recessed areas between the protruding ring-like members at 68, 70 and 72. Without regard to the direction of the pig movement in the pipeline, it moves along the pipe achieving contact with four or five scraping edges to clean the pipe. Again, the double-dished arrangement works in the manner described with regard to the embodiment 12.

The ring-like members 68, 70 and 72 are of common diameter with that of the body of the pig while their thickness might be as much as about 1 inch on a pig 8 inches in diameter. The grooves or cuts defining the rings are about 1 inch deep on an 8 inch pig. Bigger sizes vary somewhat proportionally.

Attention is next directed to FIG. 7 of the drawings where an alternative embodiment is indicated by the numeral 100. The pig 100 is equipped with a number of external rings indicated by the numerals 102, 104 and 106. The rings are spaced apart and separated by a number of grooves which are indicated generally by the numeral 108. Ports 110 are formed in the periphery to communicate with the interior of the pig in the same manner as the ports or passages 90 shown in FIG. 6. The passages expose the interior of the pig to the external pressure to equalize pressure within the pig. A significant feature of the pig 100 is the inclusion of the spiral grooves indicated at 112. The spiral grooves are found on the leading and aft portions of the pig. The spirals do not fully encircle the pig, but are found at spaced points about the circumference to be located at substantially all points about the pig. The spirals 112 located at both ends of the pig impart a slight rotative twist to the pig as it travels the pipeline. It will be appreciated that if the pig maintains the same relative posture to the pipeline as it traverses the pipeline, the wear will occur mostly at the bottom point of the pig. This will tend to wear a flat spot on the lower side of the pig and cause uneven distribution of wear about the pig as well as an uneven cleaning action. By way of con-
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The pig 100 of FIG. 7 tends to rotate ever so slightly to evenly distribute the wear. This also prevents the formation of a flat spot on the pig. In these regards, the pig 100 of FIG. 7 is improved over the other pigs. Additional grooves are found at 114. These grooves provide relief passages, it is believed, for matter which is scraped from the wall of the pipeline which is directed and channeled through the grooves away from the leading edge of the pig.

Attention is now directed to FIG. 9 of the drawings wherein a further alternative pig is indicated by the numeral 120. The pig 120 is quite similar to the pig shown in FIG. 6 of the drawings. However, the exterior surface of the pig is formed of a harder material. The pig 120 has an internal foamed core indicated by the numeral 122 which is similar in all regards to the core 78 shown in FIG. 5. A body 124 is formed about the core, and a central axis 126 is likewise a portion of the pig. As was discussed regarding the method of manufacture, and the arrangement of FIG. 5, the foam core is suspended within a mold and the body is formed about it. The body includes the axial rod or support 126 which is connected to the harder elastomer which forms the double-dished pig. Thus, the axial support 126 is cast integral with the remainder of the body as previously mentioned. However, a significant feature of the pig 120 is the inclusion of a third plastic material which is indicated by the numeral 128. The third material is found on the outer surface. Just as the body 124 is somewhat harder than the foam core 122, the outer surface or coating 128 is even yet harder than the body. The foam core 122 is a low durometer, low density, foamed polyurethane material. The body 124 might be, by way of example and not limitation, a molded urethane polymer which is cured to a hardness of perhaps 60 to 90 durometer. The outer coating 128 can readily be, by way of example and not limitation, a mix of the same liquid polymer of which the body 124 is formed having added thereto granules of tungsten carbide or some other extremely hard material. The coating 128 is a mix of a plastic binder and a hard material. It is manufactured in the following manner, utilizing FIG. 8 of the drawings.

In FIG. 8, the foam insert 122 is shown suspended in a mold which is indicated generally by the numeral 132. The mold can be disassembled and assembled to enclose the foam body 122. The foam body is held in position by a pair of pins 136. Preferably, the mold is a three piece mold having a left half 138, a right half 140, and a top 142. The mold forms the exterior of the pig to the double dished shape of the preferred embodiment. A void is left in the mold which provides for the externally facing rings and grooves in the manner of the embodiment 100 shown in FIG. 7.

The method of manufacture of the pig 120 having an externally hard surface comprised of a plastic binder and hard particles will next be considered. An opening 144 is left in the top plate 142 to permit the addition of a small but measured quantity of mixed liquid urethane polymer and hard particles. The particles again can be particles of extreme hardness, such as tungston carbide particles, or others. The liquid urethane binder and particles are added through the opening 144 which is then temporarily closed. The mold 132 is placed with its axis horizontal and is rotated at a relatively slow speed, perhaps 10 to 30 RPM. This centrifugally forces the liquid plastic binder and hard particles to the exterior of the pig. After some interval of time, the liquid dries and becomes sufficiently tacky that it will cling to the outer wall of the mold 132. At this juncture, rotation is stopped and the mold is turned vertical with the opening 144 at the top. At this juncture, the mold is completely filled to the top, and is permitted to sit until the remainder of the body is cast and becomes firm. The second addition of liquid elastomer to the mold binds the foamed core 122 to the hardened external coating previously formed on the outer wall of the mold. Thus, the completed product is fully bonded together, and yet comprises different hardneasses at different locations for purposes set forth above.

It should be noted that the molding process described above forms a double dished pig having an axial support through the center. This is in accordance with the teachings recited earlier herein. The exterior surface is extremely hard, and achieves the purposes desired as mentioned before with respect to the embodiment 120. The molding sequence described herein is perhaps the most convenient to execute and yields a finished product having a controlled external diameter so that the pig can be assigned duty in a pipeline of known nominal diameter.

The foregoing has been directed to the method of manufacture of the present invention. The pipeline pig manufactured by the method of the present invention has likewise been described. Numerous alterations and variations can be included with the present invention without departing from the scope hereof. For instance, the several dimensions of the pig can be varied within reason to provide a workable structure without departing from the scope of the present invention. The pig is utilized in the manner implied above. More specifically, the pig is placed in the pipeline and is forced through the pipeline by the pressure of the fluid flowing in the pipeline. It should be understood that the pig is forced downstream in response to either gas or liquid flow. The pig of the present invention is particularly adapted to wipe the side walls of the pipe clean. The dished ends tend to flare slightly, which enhances the gripping action of the pig at both ends against the side walls. This enhanced gripping action tends to remove paraffin coating and other accumulations within the pipeline.

The foamed elastomer may be shaped into a cone, a section of which shows two straight line segments, or it may have the form of a curve or arc. Thus, both ends may be shaped to this alternative form. The arc may be that of a circle or ellipse.

While many alterations and variations of the present invention may be incorporated, the terminology adapted herein is extended to the claims which are appended hereto.

What is claimed is:

1. A pipeline pig which comprises an elongate cylindrical body having an elongate dimension from end to end and having a cavity therewithin and adapted to fit within a pipeline and being of approximately equal diameter to the inside diameter of the pipeline; concave surfaces of a desired thickness at the opposite ends of said pig, said surfaces being formed
of a resilient material different from the material of said body and permitting some flexure thereof to enhance the gripping action of the pig as it engages the side wall of the pipe;

an elongate support member extending through the central portions of said pig for connecting said surfaces; and,
said cylindrical body being formed substantially of a resilient material.

2. The invention of claim 1 including a cylindrical core of lower density material than that of said body within the cavity of said cylindrical body of said pig and surrounding said elongate support member.

3. The invention of claim 1 including a cylindrical core of low-density polyolefin foam in said cavity in said body and a surrounding polyolefin body cast to said core and having an outer surface hardness in the range of 70 durometer or greater.

4. The invention of claim 1 including on said body a plurality of ring-like members extending to the periphery of the inside of the pipeline.

5. The invention of claim 2 further including passage means communicating the interior of the pipeline with the cavity within said body.

6. The invention of claim 2 further including an external coating on said cylindrical body which includes therein particles of a material harder than the resilient material comprising said cylindrical body.

7. The invention of claim 6 wherein said particles are tungsten carbide particles which are embedded in said resilient material.

8. The invention of claim 6 wherein said resilient material is a urethane material which is molded about said particles which extend radially inwardly from the outer face thereof a predetermined depth.

9. The invention of claim 1 wherein said cylindrical body includes spiralled grooves extending at least part-way along the length of the body thereof sufficient to impart a slight rotative twist to said pig as it traverses the pipeline.

10. The invention of claim 9 wherein said spiral grooves are found at at least two locations along the length of said body.

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