Feb. 10, 1959 D. W. FETHER **2,872,984**

PERFORATED PIPE STRUCTURE

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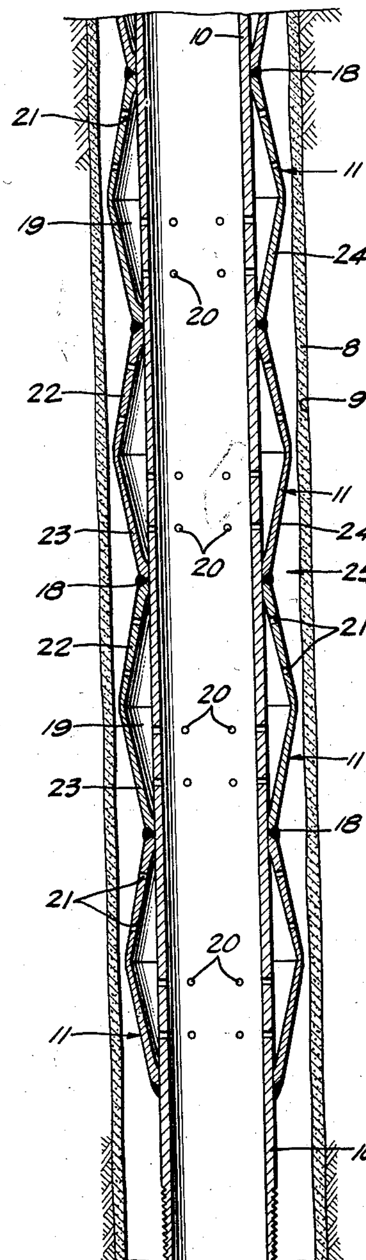

FIG. 1.

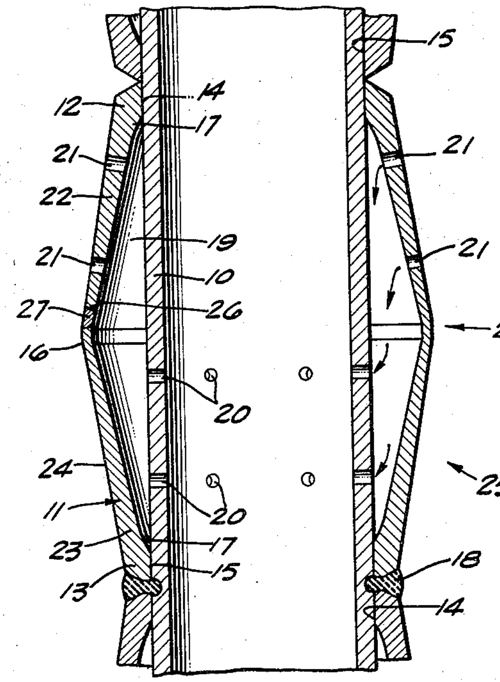

FIG. 2.

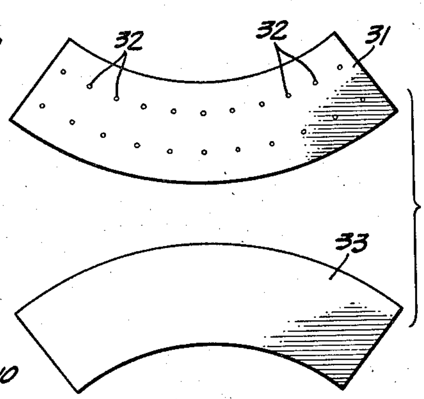

FIG. 4.

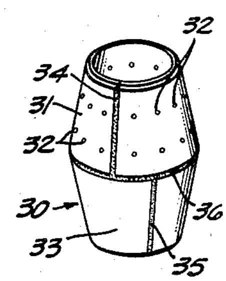

FIG. 3.

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PERFORATED PIPE STRUCTURE

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6 Claims. (Cl. 166—235)

This invention relates to well pipe structures of the type used in oil wells, and is particularly useful as a perforated liner through which oil enters the flow pipe from the well formations.

Perforated pipes have been used for many years in oil wells to screen out sand and other foreign matter while permitting the well fluid to enter the flow pipe in the well. A pump is commonly placed in the well to receive the fluid entering the well pipe through the perforations and to pump the oil to the surface through the tubing. It is known that a large number of the perforations in the pipe are plugged up as the pipe is lowered into position. This occurs because the well bore is not absolutely straight and consequently the perforated pipe scrapes on the sides of the bore as it is lowered into place. The well surface of the well bore commonly is coated with mud cake which is left as a deposit from the circulating mud fluid used in the drilling of the well. This mud cake scrapes off readily and fills up the perforations so that many of them do not function at all.

It is known that perforated well pipes have been sheared off laterally in the hole after a period of use and it is believed that this occurs when many of the perforations on one side of the pipe have become plugged so that well fluid enters only through perforations on one side of the pipe only. The increased velocity of the well fluid which develops as a result of lack of sufficient perforations causes excessive erosion of the formation on one side of the well pipe. Mud cake and rock formation parts falling into the well bore around the perforated pipe from higher locations in the well form a relatively solid pack around the perforated pipe on the side where the perforations are plugged. Radial pressure from the accumulation of this material serves as a wedge to move the perforated pipe into the eroded pocket adjacent the active perforations. Eventually, the wedging force becomes sufficiently great to collapse the perforated pipe and even to shear it off laterally.

In certain types of wells where the formation contains considerable gas dissolved in the well fluid, difficulty is encountered in operating the pump efficiently because of foaming which occurs at the active perforations. The foaming is believed to result from the momentary high velocity of the well fluid as it enters an active perforation in the pipe; the increase in velocity is accompanied by a decrease in pressure with the result that gases come out of solution to produce a foam and this foam interferes with the proper operation of the pump.

It is the principal object of my invention to provide a new and improved form of well pipe structure which has markedly increased resistance to lateral crushing, and without requiring pipe of excessive wall thickness.

Another object is to provide an improved perforated pipe structure which includes means for trowelling the walls of the well bore to prevent plugging of the perforations when the device is being lowered into the hole.

Another object is to provide an improved perforated pipe structure which functions to minimize objectionable foaming action.

Another object is to provide a device of this type which employs a plurality of barrel shaped collars mounted end-to-end on a supporting pipe, to define a series of chambers between the pipe and the collars, the pipe and collars each having perforations communicating with said chambers.

Another object is to provide a device of this type which is well suited for economical manufacture on a quantity production basis.

Other and more detailed objects and advantages will appear hereinafter.

In the drawings:

Figure 1 is a sectional side elevation showing a perforated pipe structure embodying my invention.

Figure 2 is a sectional elevation on an enlarged scale showing a preferred form of barrel shaped collar and the manner of mounting it on the supporting pipe.

Figure 3 shows a modified form of my invention, the barrel shaped collars being constructed of arcuate metal sections.

Figure 4 is a diagram showing the arcuate metal sections prior to assembly.

Referring to the drawings:

The central support member or pipe **10** is encircled by a plurality of barrel shaped collars **11** placed end-to-end. Each of these collars **11** is provided with end portions **12** and **13** having circular openings **14** and **15**, respectively, to receive the outer surface of the pipe **10**. The collars **11** are preferably formed by forging them from pipe, not shown, which has a diameter equal to the largest diameter of the central portion **16**. When formed in this manner the collar has wall sections which are thinnest adjacent the portion **16** and increase in thickness toward the end portions **12** and **13**. The increase in thickness is such that the cross sectional area of the collar wall in any plane normal to the pipe axis is substantially the same. As indicated, additional thickness may be provided adjacent the end portions **12** by upsetting at **17**. The collars **11** are placed in end-to-end abutting relationship and weld metal **18** is deposited in the V groove formed by the collar ends. This weld metal penetrates the wall of the pipe **10** so that the collars are welded to the pipe as well as to each other.

The annular chamber **19** defined between each collar and the wall of the pipe communicates through perforations **20** with the interior of the pipe **10** and through the perforations **21** to the well bore outside the collar. I prefer to place the perforations **21** in the upper tapered portion **22** of the collar which joins the center portion **16** with the end portion **12**. Also, I prefer to place the perforations **20** so that they communicate with the lower portion of the chamber **19**.

The lower tapered portion **23** of the collar which connects the central portion **16** with the lower end portion **13** is preferably imperforate and the outer surface **24** thereof serves to trowel the mud cake **8** or other material on the wall **9** of the well bore surface. When the structure **25** including the pipe **10** and collars **11** is lowered into the well bore, these tapered surfaces **24** trowel the wall of the bore to prevent plugging of the perforations **21**. The outer tapered surfaces of the collars are steeply inclined and thus the increase in diameter from one end of each collar to its mid point is only moderate. Stated in other words, the volume of each chamber is substantially less than the volume of the interior of a corresponding portion of the pipe **10**.

The perforations **20** and **21** may take the form of slots or drilled holes. The particular shape of the perforation is not critical.

If desired, gravel may be introduced into each chamber **19** through an opening **26** in the collar **11** and the opening later closed by means of a suitable plug **27**.

The composite structure **25** has very high crushing resistance because of the arch construction of the barrel shaped collars **11**. Moreover, the tensile strength of the composite structure is very nearly uniform because of the change in wall thickness of each collar **11**. Foaming of well fluid entering the interior of the pipe **10** is minimized because the perforations **21** are prevented from being plugged in the course of installation of the structure **25** in the well bore and consequently the velocity of the fluid passing through perforations **21** is maintained at a reasonably low level, thereby minimizing abrasion in these perforations.

Furthermore, the perforations **20** in the wall of the pipe **10** are not subjected to contact with the mud cake, sand or other material in the well bore, and hence they provide adequate passage area to prevent high velocity of the well fluid passing through them. Accordingly, foaming and cutting are minimized at both the collar perforations **21** and the pipe perforations **20**.

In the modified form of my invention shown in Figure 3, the barrel shaped collar **30** is similar to the collar **11** previously described except that it is formed of flat stock rolled to shape. The upper section **31** is formed as a truncated cone from a flat piece. The lower section **33** is formed as an identical truncated cone from the flat section **33**. Axially extending welds **34** and **35** and the circumferential weld **36** hold the parts in assembled relationship. The collars **30** are mounted on the pipe **10** in the same manner as described above and are held in place by welding. The upper sections **31** are provided with perforations **32** and the lower sections **33** serve to trowel the material on the wall surface of the well bore.

Removal of conventional perforated liners from wells after a period of use has been regarded as difficult, if not impossible. Conventional perforated straight pipe becomes locked in the hole after a period of use by the wedging action of mud cake, sand and other formation parts which fall from the upper portions of the bore hole into the portion where the liner is placed. Because of the reduction or elimination of sloughing in the hole and because of the high tensile strength of my composite perforated pipe structure as well as the tapered configuration of my barrel shaped members, it is anticipated that it will be possible in many cases to remove my improved device from the hole. The high strength characteristic makes it possible to employ jars to loosen the structure and it is only necessary to move the structure through a distance equal to one-half the length of one of the barrel shaped members in order to free the structure from the walls of the well hole.

The tapering wall thickness of the barrel shaped collars results in very nearly uniform bending stiffness along the length of the pipe structure as a whole. On the other hand, providing a uniform thickness of the wall of the collars would result in high bending stresses at the minor diameters leading to the development of yield hinges at these locations. Such yield hinges would comprise locations of high local plastic deformations or permanent set. The tapering wall thickness, from a minimum at the major diameter to maximum at the minor diameters, reduces the possibility of local yielding to a minimum.

Another advantage of my structure employing barrel shaped members is that its design encourages the building and maintaining of sand bridges in the well bore to prevent longitudinal sloughing of mud cake and formation material. The alternating enlargements and constrictions provided by the series of barrel shaped members encourages sand bridging and thereby furnishes a support for the mud cake and formation materials to reduce longitudinal sloughing.

It may be desirable in some cases to eliminate the perforations **21** and **20** in the lower portion of the composite structure. For example, if one thousand feet of my composite structure were to be used in a particular well, it might be desirable to eliminate the perforations in the lowermost one hundred feet. This lower unperforated portion would serve to trowel the walls of the well bore as the structure is lowered into position, and the cost of cutting the perforations in this lower section would be eliminated. Furthermore, the composite structure, using the barrel shaped collars, may be employed without perforations in the upper portion of the well, in order to take advantage of the high resistance to crushing, and the property of reducing longitudinal sloughing.

Having fully described my invention, it is to be understood that I do not wish to be limited to the details herein set forth but my invention is of the full scope of the appended claims.

I claim:

1. A pipe structure adapted to be lowered into a well bore, comprising: a central pipe, a plurality of barrel-shaped collars fixed to each other on the outer surface of the pipe in end-to-end relationship, each collar having relatively small diameter end portions and a relatively large diameter central portion therebetween, each collar cooperating with the pipe to form an annular chamber, each collar having a first tapered portion extending from the large diameter central portion to the lower end portion thereof and forming a smooth external trowelling surface for contact with the wall surface of the well, each collar having a second tapered portion extending from said central portion to the upper end portion thereof, said tapered portions providing an annular wall which is of minimum thickness at said large diameter central portion and which increases in thickness toward each end portion of the collar.

2. The device of claim 1 in which the collars are welded end-to-end.

3. The device of claim 1 in which the collars are welded end-to-end and welded to the central pipe.

4. The device of claim 1 in which the central pipe is perforated and wherein said second tapered surface of each collar is provided with perforations.

5. The device of claim 1 in which the central pipe is perforated and wherein said first tapered portion of each collar is imperforate and said second tapered portion of each collar is provided with perforations.

6. The device of claim 1 in which the cross-sectional area of the annular wall is substantially constant in any plane normal to the axis of the pipe.

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