Feb. 28, 1967 J. D. HUGHES 3,306,078

ROTARY DRILL SHOCK ABSORBER

Filed Feb. 19, 1965 2 Sheets-Sheet 1

Fig. 1

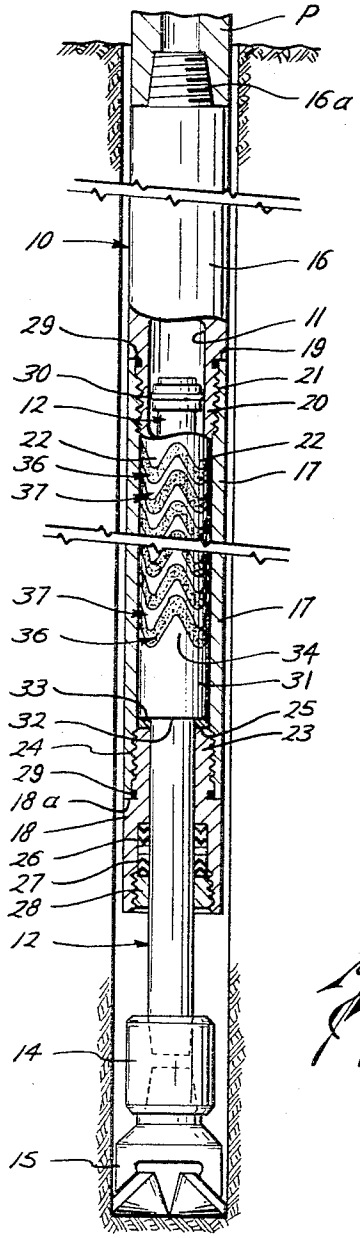


Fig. 2

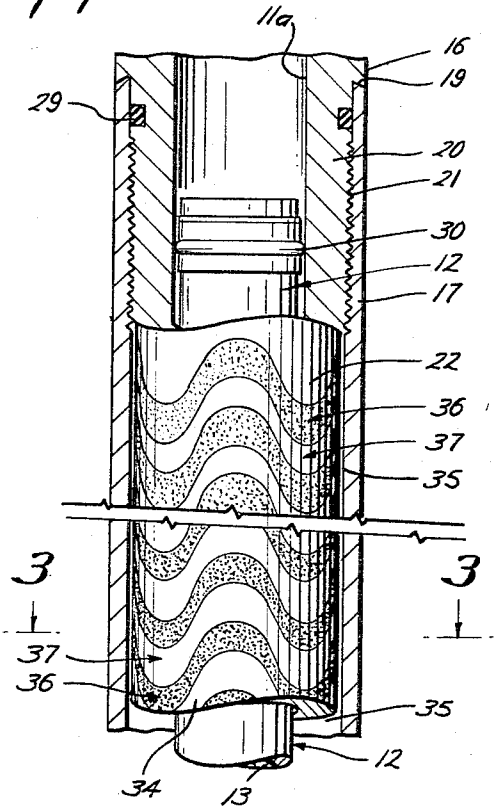
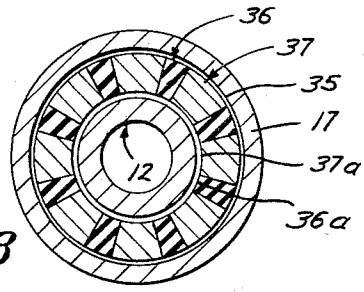


Fig. 3



James D. Hughes
INVENTOR.

BY

ATTORNEY

Feb. 28, 1967 J. D. HUGHES 3,306,078

ROTARY DRILL SHOCK ABSORBER

Filed Feb. 19, 1965 2 Sheets-Sheet 2

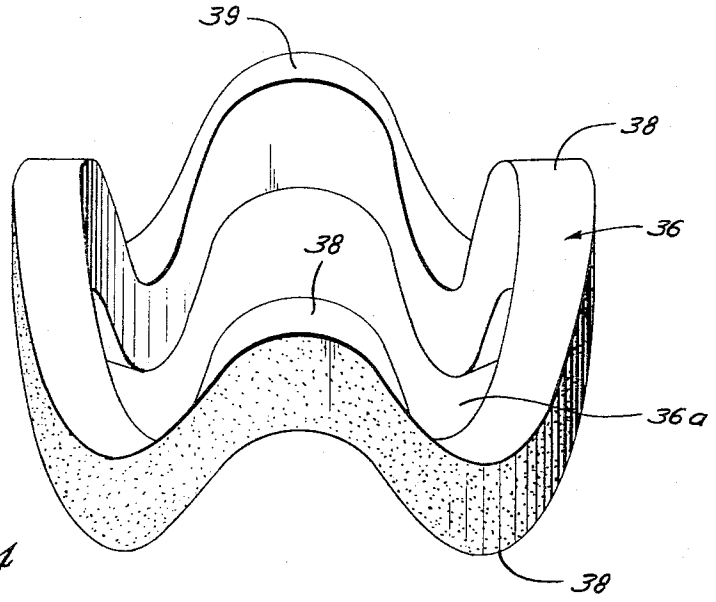


Fig. 4

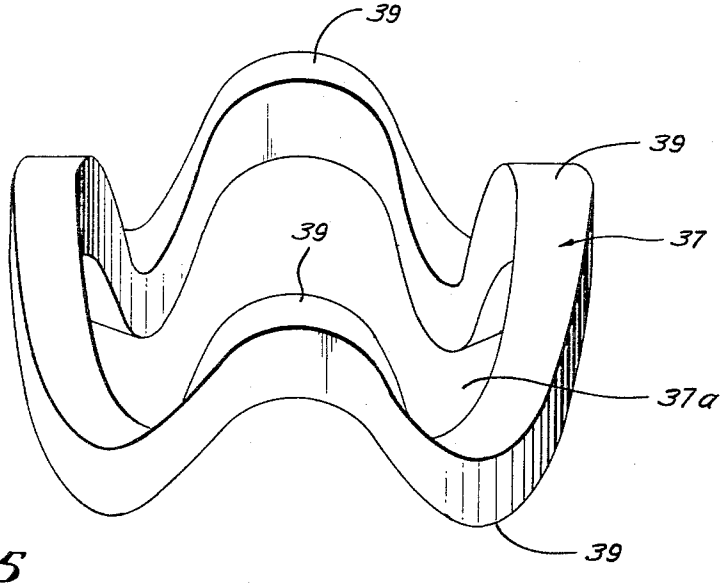


Fig. 5

James D. Hughes
INVENTOR.

BY

ATTORNEY

United States Patent Office 3,306,078
Patented Feb. 28, 1967

3,306,078

ROTARY DRILL SHOCK ABSORBER

James D. Hughes, 4714 Spellman, Houston, Tex. 77035

Filed Feb. 19, 1965, Ser. No. 434,050
8 Claims. (Cl. 64—27)

This application is a continuation-in-part of my copending application Serial No. 337,836, filed January 15, 1964, now Patent No. 3,257,827.

This invention relates to improvements in rotary drilling shock absorbers.

In the drilling of wells, such as oil and gas wells, particularly by the rotary system in which a tubular drill string carrying a bit is rotated while drilling fluid is circulated through the interior of the drill string to the area of the bit and thence upwardly through the annular space between the drill string and the well wall, the drill string is subjected to numerous types of shocks resulting from the engagement of the bit with the rock surfaces encountered during drilling. These shocks may be in the form of vertical shock waves resulting from bouncing of the bit from rock surfaces of varying hardness which it encounters and in the form of torsional shocks which result when the rotation of the bit is momentarily restrained by friction and then released when sufficient torque is imposed on the drilling string. These varying types of shocks are seriously damaging to parts of the drill string and their inhibition or elimination is greatly to be desired.

Various types of shock absorber designs have been developed in an effort to overcome the problems mentioned above. These prior designs all employ a common arrangement in providing inner and outer telescoping drive members connectible between sections of the drill string and providing an annular space therebetween in which are mounted or positioned different types of shock absorbing elements. Some are constructed with a continuous sleeve of resilient material, such as rubber, which is molded or vulcanized to both the inner and outer drive members of the device to form a permanent resilient connection therebetween.

Others employ separable rings arranged in the annular space, but in each instance employing a metal housing or frame to which resilient material is permanently vulcanized or molded, the rings being splined or keyed to the inner and outer drive members.

These prior devices are all subject to some deficiencies in use, generally requiring complete replacement of the device as a whole, or of the complete metal-resilient material elements when sufficient wear has occurred.

In my copending application Serial No. 337,836, now Patent No. 3,257,827, I have provided an improved form of shock absorber in which the shock absorbing elements comprise a "stack" or series of metal rings connected by complementary clutch teeth and having mounted between the teeth removable or replaceable resilient blocks for transmitting the necessary torque between the drive members and for absorbing the various shocks and vibration to which the drill string is subject, and which upon failure of any of the resilient elements, will automatically provide effective metal-to-metal drive connections between the drive members of the shock absorbers.

The present invention has for its principal object the provision of a further improved form of shock absorber.

In accordance with the present invention, the construction employed is generally similar to that disclosed in my copending application in the mounting in the annular space between the drive members of a series or "stack" of transfer rings having complementary clutch-type teeth for transmitting torque between the members of the shock absorbing device.

The structure, in accordance with the present invention, differs from the earlier form, however, in that the series of transfer rings is arranged to alternate rings which are constructed of metal with separate rings constructed of suitable non-metallic, resilient, deformable material, such as natural or synthetic rubber or other plastic materials.

A further difference between the present invention and that of the earlier application is in the shape of the clutch teeth which, in the present application, are formed by shaping the opposite ends of each ring throughout its circumference to form symmetrical, generally V-shaped teeth, uniformly spaced and preferably having a symmetrical rounded wave form which may best be described as "sinusoidal." The number of such teeth may vary and will be at least three in number to effectively balance the forces between the rings.

The opposed ends of the inner and outer drive members will be formed with clutch teeth of complementary shape to those on the ends of transfer rings so as to be fully engageable with the rings forming the opposite ends of the stack.

Other and more specific objects and advantages of this invention will become more readily apparent from the following detailed description when read in conjunction with the accompanying drawing which illustrates a useful embodiment in accordance with this invention.

In the drawings:

FIG. 1 is an elevational view, partly in section, showing the shock absorber device mounted in a drill string extending into a well bore;

FIG. 2 is an enlarged fragmentary, elevational view, partly in section, of the shock absorber device;

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

FIG. 4 is a perspective view of one of the non-metallic force transfer rings; and

FIG. 5 is a view similar to FIG. 4 of a metallic force transfer ring.

Referring to the drawing, the shock absorber device, in accordance with this invention, comprises a generally tubular sleeve member **10** constituting the outer drive member of the device, having an axial bore **11**, and a tubular mandrel or inner drive element **12** of somewhat smaller diameter than bore **11**. Inner member **12** also has an axial bore **13** and is threadedly received at its lower end in a lower sub **14** by which the shock absorber is threadedly connected to a drill bit **15**. It will be understood that normally one or more drill collars (not shown) will be positioned in the drill string above bit **15**, but these have not been shown as they form no part of the present invention. It will be understood that the shock absorber device may be placed anywhere in the drill string, although normal practice is to place such device at the bottom of the string above the bit and below whatever number of drill collars is installed in the string.

Outer drive member **10** is composed of an upper sub **16**, an intermediate shell **17** and a lower thrust sub **18**, which are coaxially interconnected. Upper sub **16** is provided at its upper end with a threaded pin **16***a* for connection to a drill pipe P or to a drill collar and is reduced somewhat in external diameter at a point adjacent its lower end to form the external downwardly facing shoulder **19** about the reduced diameter portion **20**. The latter is externally threaded at **21** to be threadedly received in the upper end of shell **17**, the external diameter of which is made flush with that of upper and lower subs **16** and **18**. The lower end of portion **20** terminates in an annular shoulder shaped to define the downwardly projecting circumferentially arranged clutch teeth **22** surrounding bore **11**. Lower thrust sub **18** has its upper end portion reduced somewhat in diameter to define an annu-

lar upwardly facing shoulder 18*a* about a reduced diameter portion 23 which is externally threaded at 24 to be threadedly received in the lower end of shell 17. The inner end of reduced diameter portion 23 forms an upwardly facing annular shoulder 25 surrounding the bore of sub 18. The latter is counterbored from its lower end to form the stuffing box 26 in which is positioned seal packing 27 adapted to form a fluid-tight slidable seal about mandrel 12. A gland nut 28 is screwed into the lower end of stuffing box 26 for compressing packing 27. Packing rings, such as O-rings 29—29, are positioned to seal between the ends of shell 17 and the respective threaded portions 20 and 23.

The upper end of mandrel 12, which extends into bore 11 within upper sub 16, is provided about its exterior with seal packing 30 to form a slidable fluid-tight seal between mandrel 12 and the wall of bore 11. Intermediate its ends mandrel 12 has an annular enlargement 31 which is receivable inside the bore of shell 17 and defines at its lower end a downwardly facing annular shoulder 32 which is abuttable against shoulder 25 of the lower thrust sub. A thrust ring 33, such as a Teflon ring, may be mounted between shoulders 25 and 32. The upper end of enlargement 31 defines an annular upwardly facing shoulder which is formed to provide upwardly projecting, circumferentially arranged clutch teeth 34 which are complementary to clutch teeth 22 on the lower end of portion 20 of the upper sub. The difference between the external diameter of mandrel 12 and the interior diameter of shell 17 defines an annular space 35 (FIG. 2) terminating at its opposite ends in the shoulders carrying the oppositely facing clutch teeth 22 and 34.

A plurality of force transfer rings 36 constructed of non-metallic, resilient, deformable material, such as natural, or synthetic rubber or other plastic materials, and identically shaped rings 37 constructed of metal, are disposed or stacked in alternating superimposed coaxial relation in annular space 35, the rings 36 and 37 having axial bores 36*a* and 37*a*, respectively, through which mandrel 12 extends. The opposite ends of each of the rings 36 and 37 are shaped to provide oppositely extending, generally V-shaped clutch teeth 38 and 39, respectively, of a regular symmetrical form, uniformly spaced about the axis of the ring, the teeth on the rings being substantially identical in shape to those comprising clutch teeth 22 and 34. As illustrated in the preferred form, both the peaks and valleys defining the teeth are smoothly rounded so that the teeth define a shape which may descriptively be termed "sinusoidal."

In the preferred form, as illustrated, the entire body of each ring will be shaped to the sinusoidal form, so that, when engaged, all sections through any adjacent pair of metal-non-metal rings will be substantially equal. It will be understood, however, that the ring bodies may be extended in length, if desired, so as to provide a longitudinal section of cylindrical shape between the ends having the desired sinusoidal or V-shape.

By employing force transfer rings, alternately of metal and plastic composition, having the specialized shape illustrated and described herein, a maximum degree of efficiency is attained both in shock-absorption, and torque transmission, with minimum wear and attrition.

In assembly of the shock absorber, the number of transfer rings employed may be varied as desired to conform with the load requirements in each installation. When the drill string is rotated, the torque required to rotate the bit will be transferred through the engaged clutch teeth and the intervening transfer rings which, when arranged as described, will efficiently transmit the torque while at the same time, effectively absorbing both vertical vibrations and torsional shocks occurring during the drilling operation.

The several seals provided between the inner and outer parts of the tool will prevent entrance of the circulating drilling fluids and well fluids which may be encountered into annular space 35, and thereby prevent erosion or other deleterious effects thereof, particularly on the non-metallic transfer rings. When the transfer rings have become sufficiently worn to require replacement, it will be seen that it is only necessary to replace those rings which have been sufficiently worn. Accordingly, it will be seen that the device constitutes a very economical construction having exceptionally effective torque transfer and shock absorbing efficiency.

As noted, transfer rings 36 may be made of natural or synthetic rubber, or of any of the resilient plastic compositions which are now available, including such materials as nylon, which may be re-enforced with glass fibers or other flexible re-enforcing materials. Rings 37 may be made of any suitable metal and will usually be constructed of one of the stronger alloy steels.

It will be understood that various changes and modifications may be made in the details of the illustrative embodiment within the scope of the appended claims but without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. A rotary drilling shock absorber, comprising, an outer tubular member having an axial bore and connectible at one end to one section of rotary drilling string, an inner tubular member having an axial bore connectible at one end to another section of said rotary drilling string and inserted into the bore of said outer member to define an annular space therebetween, opposed annular shoulders on the respective members at opposite ends of said annular space, each of said shoulders carrying a continuous series of oppositely facing circumferentially spaced clutch teeth, a plurality of force transfer rings stacked in the annular space concentrically between the members, the opposite ends of each of said transfer rings carrying a continuous series of oppositely facing clutch teeth of complementary shape and spacing to those carried by said shoulders and by each of the other transfer rings, alternate ones of said rings being constructed of metal and the intervening rings of deformable resilient non-metallic material, and all of said clutch teeth being of a symmetrical generally V-shape.

2. A rotary drilling shock absorber according to claim 1 including seal means arranged between said inner and outer members to seal off said annular space from the bores of said members.

3. A rotary drilling shock absorber, comprising, an outer tubular member having an axial bore and connectible at one end to one section of rotary drilling string, an inner tubular member having an axial bore connectible at one end to another section of said rotary drilling string and inserted into the bore of said outer member to define an annular space therebetween, opposed annular shoulders on the respective members at opposite ends of said annular space, said shoulders carrying a continuous series of oppositely facing circumferentially spaced clutch teeth, a plurality of separate force transfer rings stacked in the annular space concentrically between the members, the opposite ends of each of said transfer rings carrying a continuous series of oppositely facing clutch teeth of complementary shape and spacing to those carried by said shoulders and by each of the other transfer rings, alternate ones of said rings being constructed of metal and the intervening rings of deformable resilient non-metallic material, and all of said clutch teeth being of symmetrical V-shape, the peaks and valleys defining said teeth being rounded to define a continuous sinusoidal configuration for said series.

4. A rotary drilling shock absorber according to claim 3 including seal means arranged between said inner and outer members to seal off said annular space from the bores of said members.

5. A rotary drilling shock absorber, comprising, an outer tubular member having an axial bore and connectible at one end to one section of rotary drilling string, an inner tubular member having an axial bore connectible at one end to another section of said rotary drilling string

and inserted into the bore of said outer member to define an annular space therebetween, opposed annular shoulders on the respective members at opposite ends of said annular space, said shoulders carrying a continuous series of oppositely facing circumferentially spaced clutch teeth having a symmetrical sinusoidal configuration, a plurality of force transfer rings stacked in the annular space concentrically between the members, the entire body constituting each of said transfer rings being of sinusoidal configuration whereby to define continuous series of facing clutch teeth of complementary shape and spacing to those carried by said shoulders and by each of the other transfer rings, alternate ones of said rings being constructed of metal and the intervening rings of deformable resilient non-metallic material.

6. A rotary drilling shock absorber according to claim 5 including seal means arranged between said inner and outer members to seal off said annular space from the bores of said members.

7. A rotary drilling shock absorber, comprising an outer annular member having an axial bore and connectible at one end to one section of a rotary drilling string, an inner tubular member having an axial bore connectible at one end to another section of said rotary drilling string and inserted into the bore of said outer member to define an annular space therebetween, a plurality of unbonded, independent, resilient non-metallic force transfer elements disposed in said annular space a non-deformable transfer element between each pair of resilient transfer elements; and cooperating means on said transfer elements and said inner and outer members having interlocking means providing for transfer of axial and rotary loads.

8. A rotary drilling shock absorber, comprising, an outer tubular member having an axial bore and connectible at one end to one section of rotary drilling string, an inner tubular member having an axial bore connectible at one end to another section of said rotary drilling string and inserted into the bore of said outer member to define an annular space therebetween, opposed annular shoulders on the respective members at opposite ends of said annular space, each of said shoulders carrying a continuous series of oppositely facing circumferentially spaced clutch teeth, a plurality of force transfer rings stacked in the annular space concentrically between the members, the opposite ends of each of said transfer rings carrying a continuous series of oppositely facing clutch teeth, said clutch teeth on confronting ends of said transfer rings and said shoulders of complementary shape and spacing, alternate ones of said rings being constructed of non-deformable material and the intervening rings of deformable resilient material, said clutch teeth on said confronting shoulders and said rings interlocking and providing for transfer of axial and rotary loads.

References Cited by the Examiner

UNITED STATES PATENTS

497,905	5/1893	Beekman	64—2
2,084,080	6/1937	D'Aubarede	64—11 X
2,620,165	12/1952	Crickmer	64—27
2,848,884	8/1958	Maud	64—11 X
2,910,843	11/1959	Happ et al.	64—11
3,045,763	7/1962	Perrott	64—27 X
3,232,362	2/1966	Cullen et al.	64—27 X

FRED C. MATTERN, JR., *Primary Examiner.*

HALL C. COE, *Examiner.*