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Curington

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[54] **THREADED CONNECTOR FOR IMPACT DEVICES**

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[52] **U.S. Cl.** **173/132,** 173/78, 173/80

[51] **Int. Cl.** **E21b 1/06**

[58] **Field of Search** 173/131, 132; 175/320, 409, 175/414–420; 287/125; 285/338, 355, 357, 422

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[57] **ABSTRACT**

An impacting apparatus in which a threaded connection is provided between an anvil and a drill bit connected thereto, a malleable member located between the anvil and bit threads insuring a more uniform load distribution over the thread surfaces, the blows on the anvil being transmitted directly to the bit without passing through the malleable member.

21 Claims, 8 Drawing Figures

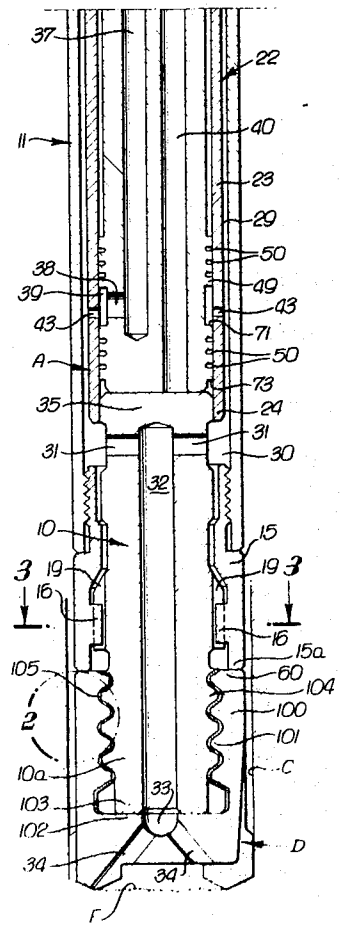


FIG. 1a.

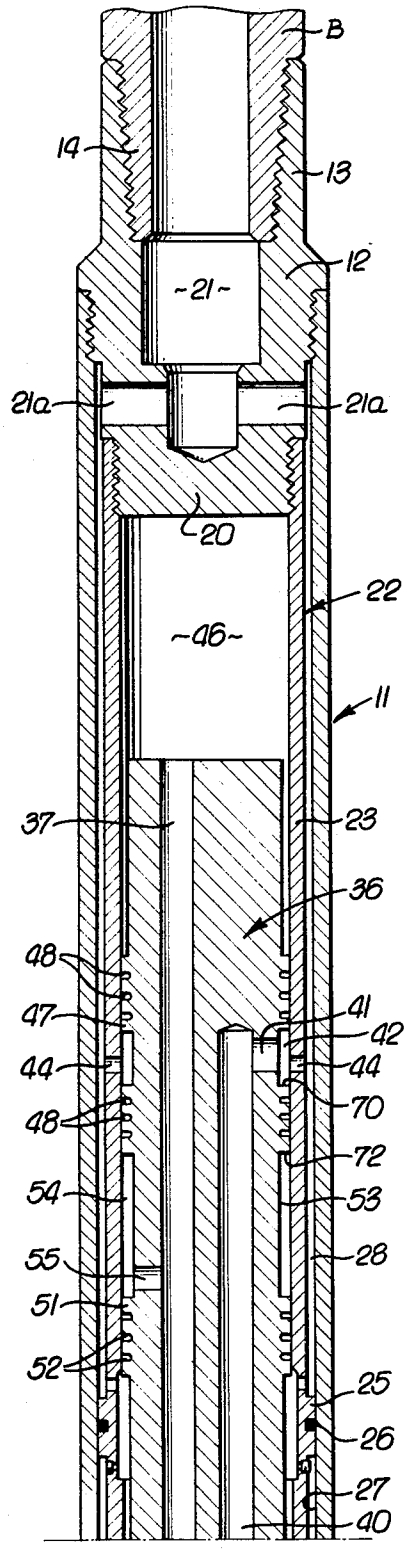


FIG. 1b.

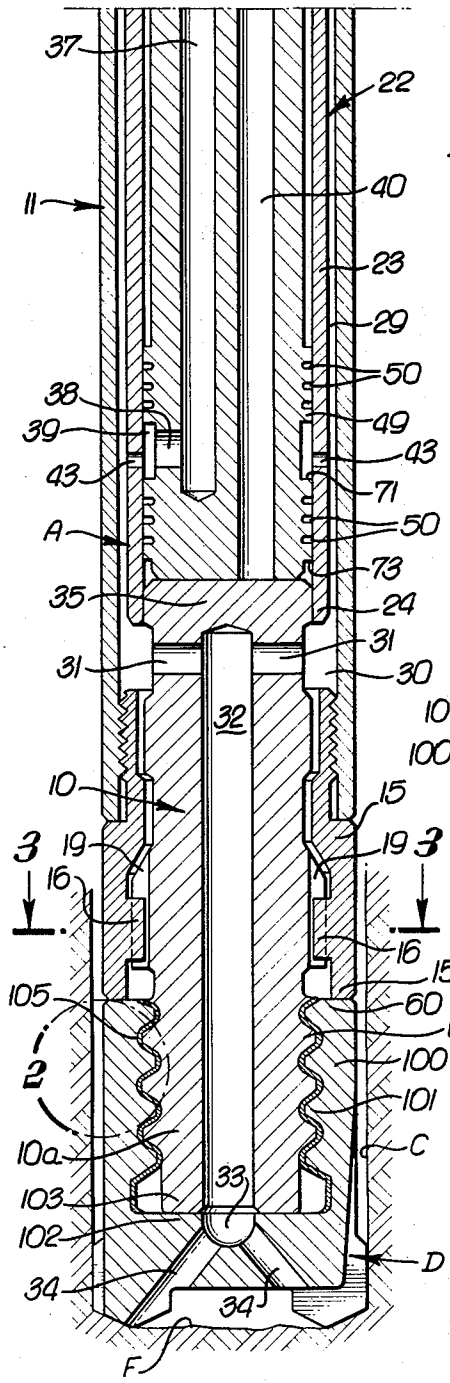
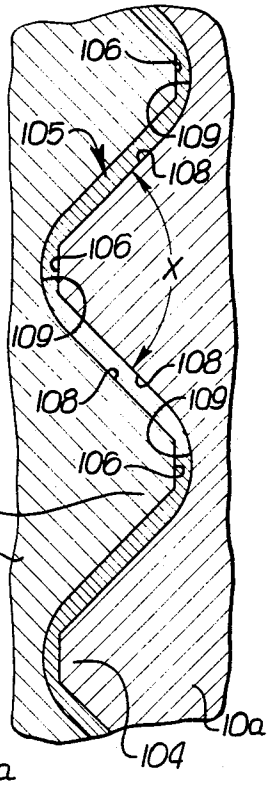


FIG. 2.



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FIG. 4.

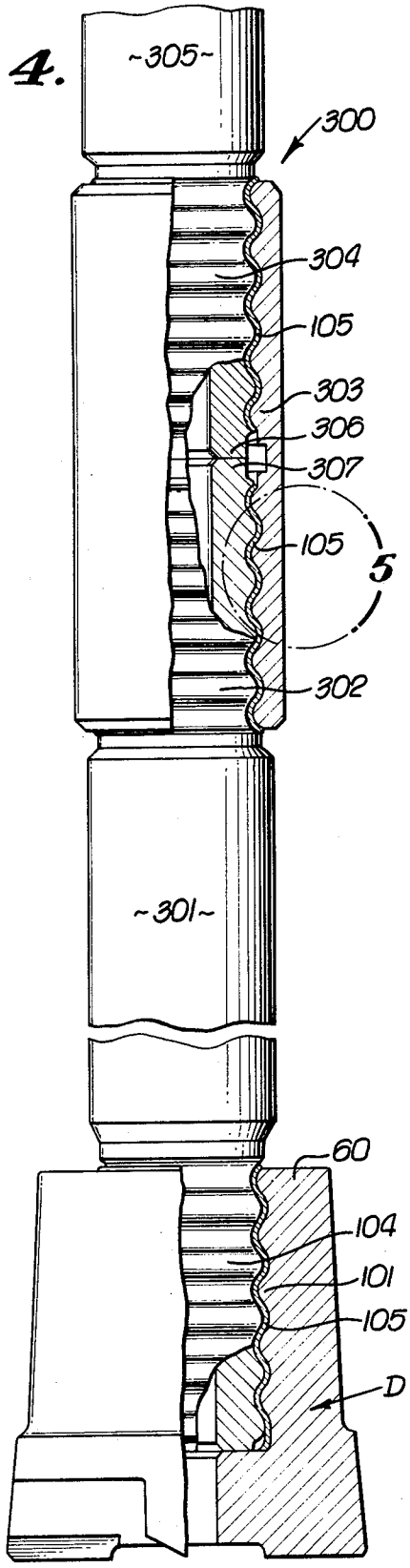


FIG. 3.

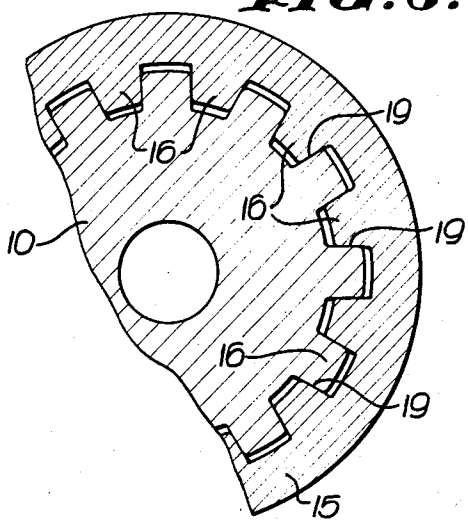
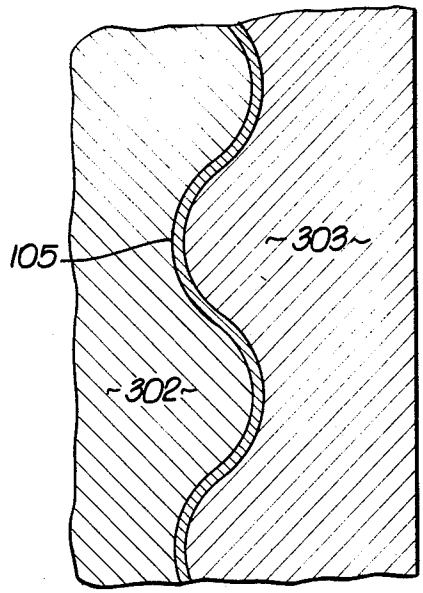


FIG. 5.



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FIG. 6.

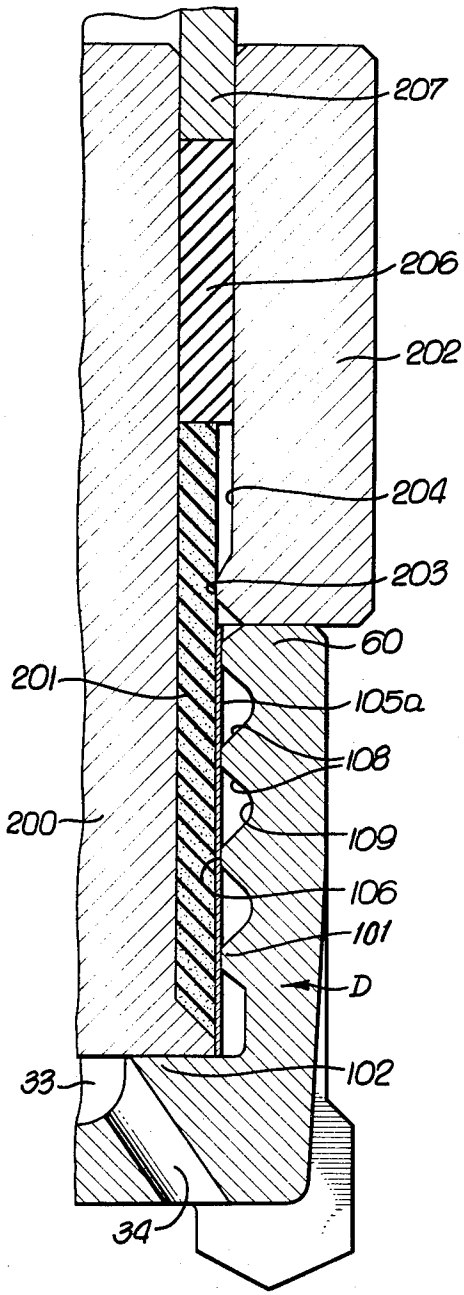
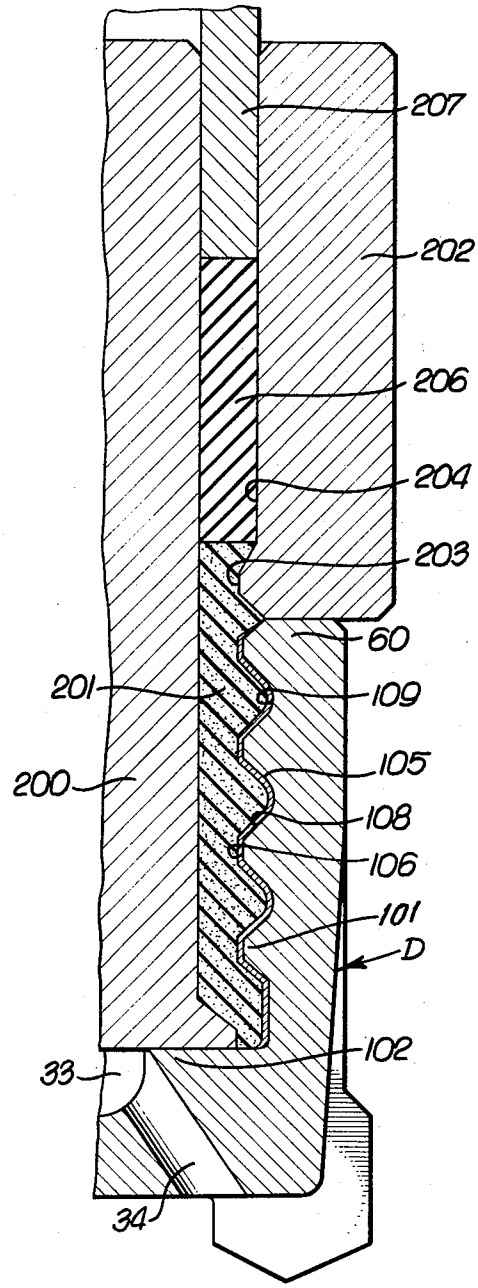


FIG. 7.



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THREADED CONNECTOR FOR IMPACT DEVICES

The present invention relates to percussive drilling apparatus, and more particularly to apparatus embodying threaded connectors or couplings in the path of transmission between the percussive source and the drill bit.

In percussive anvil and bit devices, such as used in air hammers, the anvil and bit have been made integral with one another, except in small hand-held machines, involving substantial cost and relatively low effective life of the anvil portion, since it is discarded with the worn or damaged bit portion of the combination. With the view of making the anvil reusable, attempts have been made at threadedly connecting the bit to the anvil, enabling the worn bit to be disconnected from the anvil and a new or replacement bit threadedly secured to the latter. Such attempts have been unsuccessful since breakage occurs at the threaded region, which may be due to fatigue failure. Polishing, rolling, shock peening, nitriding, and other methods of improving the finish of the threads, or inducing compressive stresses in the threads, have been tried in an effort to overcome the breakage difficulty, but without success.

It is believed that prior failures are caused by imperfect thread fits, and not necessarily by imperfect threads. Since it is not possible, as a practical matter, to produce mating pin and box threads that match perfectly, initial contact between the threads occurs at only a few points. During drilling, the hammering action applied to the threads is concentrated at those few points, effecting deformation at such points, with resultant very high localized stresses, fatigue cracks occuring at the points of high stress. Even with a theoretically perfect thread form, the same undesirable result would be achieved, since the difference in pitch diameters between the box and pin threads required for assembly causes the thread forms or profiles to be different.

By virtue of the present invention, a threaded connection is provided in the path of impact blow transmission between a percussive source and a drill bit, as between the anvil portion and bit of a percussive drilling apparatus, which virtually eliminates fatigue failures at the threaded region, thereby resulting in a threaded connection having a greatly increased useful life, enabling worn bits to be replaced without the necessity for also replacing other parts or portions of the apparatus that are still in operable condition.

Additionally, a threaded connection is provided in which the loads are distributed more uniformly over the thread surfaces, thereby eliminating high localized stresses which initiate fatigue cracks and failures. Uniform load distribution occurs despite some imperfections or mismatching of the interfitting threads.

Another object of the invention is to provide a threaded connection in which more uniform distribution of load over the threaded surfaces is achieved, with the interfitting threads being of divided pitch; that is, multiple start threads.

In general, the objectives of the invention are achieved by placing a ductile material between the mating thread surfaces, such material deforming or yielding under load, thereby causing substantially the full surface areas of the threaded surfaces to share the load and preventing concentration of the load at a few points of the threads. The ductile material, such as a malleable metal insert, can be either loosely inserted or physically attached to the pin or box threads, preventing pressure at any point in the threaded connection from exceeding the yield strength of the ductile material, thereby eliminating any high uneven loading of the thread surface that might exceed the yield strength of the pin or box material, which could produce local failure or cracks and ultimate failure of the threaded connection.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several forms in which it may be embodied. Such forms are shown in the drawings accompanying and forming part of the present specification. These forms will now be described in detail for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense.

Referring to the drawings:

FIGS. **1***a* and **1***b* together constitute a longitudinal section through an apparatus embodying the invention disposed in a bore hole, FIG. **1***b* being a lower continuation of FIG. **1***a;*

FIG. **2** is an enlarged fragmentary section taken in the encircled region **2** of FIG. **1***b;*

FIG. **3** is an enlarged cross-section taken along the line **3—3** on FIG. **1**b;

FIG. **4** is a side elevational and longitudinal sectional view of another embodiment of the invention;

FIG. **5** is an enlarged fragmentary section taken in the region **5** of FIG. **4**;

FIG. **6** is a longitudinal section through an apparatus for deforming and securing a malleable sleeve in the threaded box portion of a percussive drilling bit; and

FIG. **7** is a view similar to FIG. **6** illustrating the sleeve pressed into the bit threads.

The invention is illustrated in the drawings as applied to a downhole drilling hammer A connected to the lower end of a string of drill pipe B extending to a drilling rig (not shown) at the top of a bore hole C, and by means of which the apparatus and a drill bit D connected to its lower end are rotated while compressed air or any other suitable fluid medium is pumped down the drill pipe for operating the apparatus. The drill bit D is of any suitable type, and may have its end face tipped with tungsten carbide (not shown) for impacting against the bottom F of the bore hole while the apparatus A and bit D are being rotated, to insure drilling action against the full area of the bottom of the hole as a result of an impacting action imparted to an anvil **10** threadedly connected to the drill bit.

The drilling hammer apparatus A includes an outer elongate housing **11**, the upper end of which is threadedly connected to an upper sub **12** having an upper threaded box **13** for attachment to the lower pin **14** of an adjacent drill pipe section B. The lower end of the tubular housing is threadedly secured to a lower sub **15** surrounding the upper portion of the anvil **10**. This sub has drive keys **16** fitting in elongate grooves or keyways **19** in the anvil **10**. Accordingly, turning effort or drilling torque can be transmitted from the drill pipe B through the upper sub **12** and housing **11** to the lower sub **15**, and from the lower sub to the anvil **10**, which can move longitudinally within and relative to the lower sub and housing **11**, as described hereinbelow.

The upper sub 12 terminates in a head 20 closing the lower end of a central passage 21 through the upper sub, and which forms the upper head of a cylinder 22 that includes a cylinder sleeve 23, the upper end of which is threadedly secured to the head 20, and which extends downwardly in the housing, its lower end 24 terminating a predetermined distance above the upper end of the lower sub 15. This cylinder sleeve has an intermediate external flange or head 25 fitting closely within the housing, this flange carrying a suitable side seal ring 26 sealingly engaging the inner wall 27 of the housing. The cylinder sleeve has a reduced diameter above and below the flange, providing an upper high pressure annular passage 28 between it and the housing, and also a lower low pressure or exhaust annular passage 29 between the lower portion of the cylinder sleeve and the inner wall of the housing. This low pressure passage 29 opens into the space 30 below the sleeve 23, communicating through inlet ports 31 in the anvil with a central passage 32 in the latter that communicates with a companion passage 33 in the drill bit. The air or other fluid in the passage 33 is capable of passing through the bit passages or nozzles 34, jetting against the bottom of the hole, so as to clean the hole bottom F, as well as the bit itself, of cuttings, and to flush the cuttings upwardly around the bit D and drilling apparatus A and through the annular space between the drill pipe and wall of the bore hole to the top of the latter.

The anvil 10 terminates in an upper imperforate impact head 35 fitting snugly, but slidably, within the lower end of the cylinder sleeve 23. The impact head of the anvil is adapted to be struck by an elongate hammer piston 36 reciprocable within the cylinder sleeve 23, this piston having a longitudinal impact passage 37 opening through its upper end and communicating through a lower exhaust port 38 with an external circumferential exhaust piston groove 39. The piston also is provided with a hammer return longitudinal passage 40, opening through its lower end and communicating at the upper portion of the piston with an inlet port 41 opening into an external peripheral piston groove 42.

The cylinder sleeve 23 has one or more lower exhaust ports 43 extending between the low pressure annular passage 29 and the lower interior portion of the cylinder sleeve, and also has one or more inlet ports 44 in the upper portion of the cylinder sleeve establishing communication between the high pressure annular passage 28 and the upper portion of the interior of the cylinder sleeve. The longitudinal distance between the lower piston exhaust port 38 and the upper piston inlet port 41 is equal to the longitudinal distance between the inlet ports 44 and the exhaust ports 43. The exhaust ports 43 are so related to the upper end of the anvil 10 when the anvil is fully telescoped upwardly within the housing 11 that the lower end of the hammer piston 36 is engaging the anvil when the inlet ports 44 are aligned with the upper piston groove 42 and the exhaust ports 43 are aligned with the exhaust groove 39 at the lower portion of the piston, as disclosed in FIGS. 1a and 1b. With the piston 36 in this lower position, high pressure air can flow from the high pressure annulus 28 through the cylinder ports 44, groove 42 and piston inlet port 41 into the hammer return passage 40, passing to the lower end of the piston and exerting an upward force on the piston to shift it upwardly toward the upper cylinder head 20. At the same time, the air in the cylinder space 46 above the piston can pass through the impact passage 37 and through the exhaust port 38, exhaust groove 39 and cylinder exhaust ports 43 into the low pressure annular passage 29, flowing downwardly therearound and through the anvil inlet ports 31 into its central passage 32 for discharge through the bit D.

The upper peripheral groove 42 is formed in an upper land 47 of the piston that makes a close sliding fit with the inner wall of the cylinder sleeve 23. On opposite sides of the groove 42, the land is provided with a plurality of circumferential labyrinth seal grooves 48 to inhibit leakage of fluid between the periphery of the land and the inner wall of the cylinder sleeve. Similarly, the lower exhaust groove 39 is provided in a lower land 49 that makes a close sliding fit with the inner wall of the cylinder sleeve 23, this land also having labyrinth seal grooves 50 on opposite sides of the exhaust groove 39 for minimizing leakage of fluid between the lower land and the inner wall of the cylinder sleeve. The piston has an intermediate land 51 slidably and sealingly engaging the inner wall of the cylinder and also provided with labyrinth seal grooves 52 in its periphery to prevent leakage of fluid between the land 51 and the cylinder wall. The piston also has a reduced diameter portion 53 between the upper and intermediate lands 47, 51, to define with the cylinder wall an elongate high pressure circumferential groove 54 communicating with a side port 55 in the piston that extends from the lower portion of the groove 54 to the impact passage 37. When the piston 36 is in an elevated position, the high pressure groove 54 is in communication with the inlet ports 44 through the cylinder sleeve, so that high pressure air can flow through the sleeve ports 44 and high pressure groove 54 through the inlet port 55 into the impact passage 37 and into the cylinder space 46 above the piston for the purpose of driving the hammer piston 36 downwardly to strike an impact blow upon the lower anvil 10.

The lower side 70 of the upper peripheral groove 42 will shut off fluid flow through the ports 44 and into the hammer return passage 40 at the same time that the lower side 71 of the lower peripheral exhaust groove 39 shuts off the lower exhaust ports 43. When this occurs, high pressure air can no longer flow through the hammer return passage 40 to the lower end of the cylinder sleeve to elevate the piston 36, nor can any further air in the cylinder above the piston flow through the impact passage 37 and exhaust ports 38, 43. In addition, the lower end 72 of the upper land 47 at the upper end of the elongate high pressure piston groove 54 will open the inlet ports 44 at the same time that the lower end 73 of the lower land 49 opens the exhaust ports 43 as a result of elevation of the piston in the cylinder sleeve. Thus, there will be communication of high pressure air with the high pressure groove 54 communicating with the impact passage 37 simultaneously with communication of the air under pressure below the piston 36 with the cylinder sleeve exhaust ports 43.

From the foregoing description, it will be noted that the upper inlet ports 44 and the lower exhaust ports 43 are simultaneously shut off from communication with the hammer return passage 40 and the impact passage 37, and that they are brought into simultaneous communication with the impact passage 37 and the

hammer return passage **40** during upward travel of the piston **36** in the cylinder **22**. The piston can continue travelling upwardly in the cylinder sleeve **23**, but in view of the elongate high pressure passage **54** surrounding the piston, and the disposition of the lower end of the piston above the exhaust ports **43**, the introduction of high pressure air into the cylinder space **46** above the piston and the exhaust of air from below the piston to the low pressure annular passage **29** continues.

In the operation of the drilling hammer, the drill bit D is secured to its anvil **10** and the drill pipe B to its upper end, whereupon it is lowered in the bore hole C. When the drill bit contacts the bottom F of the hole, it comes to rest and the apparatus A is shifted downwardly along the anvil **10** until the lower end **15***a* of the sub **15** engages the upper end **60** of the bit D, permitting a suitable amount of drilling weight to be imposed upon the apparatus and the bit to retain the latter in contact with the hole bottom. The drill pipe B is then rotated to rotate the bit D and compressed air at an appropriate pressure pumped down the drill pipe and into the apparatus A. At the beginning of the impacting operation of the apparatus, the hammer piston **36** will be disposed in its lower position, as illustrated in FIGS. 1*a*, 1*b*, resting upon the upper end **35** of the anvil **10** which is then disposed in sealing relation within the lower end of the cylinder sleeve **23**. With the piston in this position, the impact passage **37** communicates with the exhaust ports **43**; whereas, the hammer return or elevating passage **40** communicates with the high pressure ports **44**. Air under pressure then flows from the sub passage **21** through its side ports **21***a* into the high pressure annulus **28** and the piston return passage **40** to the lower end of the piston, acting upon the full cross-sectional area of the piston to shift it upwardly within the cylinder sleeve **23**. As the piston is moved upwardly by the compressed air, the upper land **47** and its shoulder **70** shut off flow of the fluid through the inlet ports **44** to the return passage **40** simultaneously with the shutting off of flow of fluid by the lower land **49** and its shoulder **71** from the cylinder space **46** above the piston **36** through the impact passage **37** and through the exhaust ports **43**. At this time, the high pressure air or other gas below the piston **36** has imparted a certain amount of kinetic energy to the piston, the high pressure air below the piston expanding to continue the upward movement of the piston within the cylinder sleeve **23** and compressing the low pressure air in the cylinder space **46** above the piston. The piston will continue to rise in the cylinder as a result of expansion of the high pressure air therebelow until the lower end **73** of the lower piston land **49** opens the exhaust ports **43**, the inlet ports **44** being opened at the same instant, by movement of the shoulder **72** above the ports **44**, to communication with the high pressure piston groove **54** that communicates with the impact passage **37**. During expansion of the high pressure gas below the piston, additional kinetic energy is imparted to the piston, the high pressure air below the piston then exhausting from below the piston through the exhaust ports **43** into the low pressure annulus passage **29**, from which it can flow through the anvil ports **31** and through the central anvil passage **32** and through the drill bit to flush the cuttings from the bottom of the hole and upwardly around the bit and the annulus surrounding the drill pipe to the top of the bore hole. The piston **36** continues moving upwardly in the cylinder until its kinetic energy is overcome by the high pressure air flowing through the impact passage **37** and into the cylinder space **46** above the piston. The air trapped above the piston will have been compressed by the upward travel of the piston in the cylinder **22**, but on the return or down stroke of the piston under the influence of high pressure air in the upper portion **46** of the cylinder, the energy in the trapped air will be released and assist in propelling the piston downwardly within the cylinder. Such downward or power stroke of the piston will commence when the compressed air in the cylinder above the piston equals the kinetic energy of the ascending piston, reducing the kinetic energy and the velocity of the piston to zero at the top of the stroke. At this time, the piston will still be a short distance away from the upper cylinder head **20** and will be prevented from impacting thereagainst.

The high pressure air being fed into the cylinder space **46** above the piston **36** then drives the piston downwardly on its power stroke, such high pressure air being fed into the upper portion of the cylinder until the lower end **72** of the upper land **47** closes the inlet ports **44**, which action will occur simultaneously with closing of the exhaust ports **43** by the lower end **73** of the lower land. However, the air pressure in the cylinder below the piston **36** is then at the low value of that existing in the low pressure annular passage **29**, so that the piston can continue moving downwardly at high velocity to impact against the upper end **35** of the anvil **10**.

When the piston hammer **36** strikes the anvil, the exhaust ports **43** again communicate with the impact passage **37**, allowing the compressed air in the cylinder space above the piston to exhaust into the low pressure annular passage **29** and then through the ports **31**, anvil passage **32** and drill bit passage **33**, **34** into the bore hole C. At the same time, the inlet ports **44** in the sleeve **23** are again communicating with the piston return passage **40** so that high pressure air is again conducted through such passage into the cylinder sleeve **23** below the piston to again elevate the piston **36**, resulting in repetition of the cycle of operation of the equipment.

The general drilling hammer arrangement illustrated in the drawings forms the subject matter of applicant's application for "Down-Hole Drilling Hammer," Ser. No. 863,988, filed Oct. 6, 1969, now U.S. Pat. No. 3,606,930. As illustrated in FIGS. 1 to 3, the drill bit D is threadedly connected to the lower portion **10***a* of the anvil so that the bit can be replaced when necessary without necessitating replacement or discarding of the anvil. As specifically shown, the drill bit has an upper threaded box **100** formed with internal straight threads **101**, such threads extending downwardly from the upper end **60** of the box, the box terminating in a bottom or lower end wall **102** engaged by the lower end **103** of the anvil, the impacting force imparted by the hammer piston **36** on the anvil being directed from the lower end **103** of the anvil directly to the lower portion of the bit. Thus, the bit D is threaded on the anvil until the end wall **102** of the bit firmly engages the lower end **103** of the anvil, the impact blows being transmitted

directly from the anvil to the bit, without any substantial portion of the impact load being transmitted from the external threads **104** on the anvil that mesh, through an intervening malleable sleeve **105**, with the internal threads **101** of the box. The reactive force of the anvil, however, will be transmitted from the external threads **104** through the malleable sleeve **105** to the box threads **101**.

The internal threads **101**, and also the external threads **104**, are generally V-shaped threads, the crests **106** of which have been flattened and the root portions **109** of which are rounded. The malleable sleeve **105**, which may be of any suitable material, such as copper or aluminum, may be press fit into either the box by deforming the sleeve snugly into engagement with the thread surfaces **108**, **106**, **109**, or it may be pressed against the similar thread surfaces of the external anvil threads **104**. In any event, it will be deformed so as to make a snug engagement with all surfaces of the straight internal threads and all surfaces of the mating external threads. If desired, the threaded sleeve **105** can be preformed and inserted loosely into the box **100**, the anvil **10** being threaded into such sleeve, the tightening of the bit D on the anvil producing the intimate contact between the sleeve **105** and the internal and external thread surfaces described above. The sleeve material, being ductile or malleable, will be deformed by the threads where necessary to insure the uniform contact of the ductile material with the external and internal threads **104**, **101** and to insure even loading of the thread faces **108**. Such deformation will even occur under the repeated impact blows struck by the hammer **36** upon the anvil **10** and transmitted through the anvil to the bit D, as well as under the reactive forces resulting from the rebound of the anvil after the blow is struck thereagainst, and due to reflective waves that might travel through the anvil.

It is to be noted that the male and female threads **104**, **101** are straight threads. The included angle *x* between the thread faces or flanks **108** is preferably 90°, which adds greatly to the thread strength. In addition, the straight threads are multiple start, such as two-start, threads, which facilitates the threading and unthreading of the bit onto and from the anvil. Any mismatching between such multiple start or divided pitch of threads is compensated for by the deformation of the malleable or ductile intervening sleeve **105**, since the material of the sleeve will be displaced or flow wherever necessary as a result of the tight makeup of the bit on the anvil, more uniformly distributing the load over the thread surfaces.

The thickness of the ductile sleeve is suitably chosen. As an example, it may vary from about 0.010 to 0.020 inches in thickness. In lieu of employing a preformed sleeve, the malleable material, such as copper, can be plated onto the box threads **101**. In the plating operation, the thickness of the sleeve **105** is somewhat limited; for example, being of the order of about 0.008 inches in thickness. Such relatively thin plating, although effective, may not be as effective as the provision of a thicker sleeve of material, since the copper plating will bond to the base material therebeneath and may not yield or cushion properly to avoid high localized stresses during the operation of the hammer apparatus.

FIGS. **6** and **7** illustrate a method of deforming a sleeve **105** made of a malleable or ductile material, such as copper or aluminum, into the box threads **101** of the drill bit D. A straight cylindrical sleeve **105***a* of an appropriate thickness, for example, 0.040 inches, is inserted into the box **100**, the outside diameter of this sleeve closely conforming to the diameter of the thread crests **106** of the box, the sleeve extending from the end wall **102** of the box to its outer end **60**. A mandrel **200** of steel, or other suitable material, is then inserted into the box **100**, this mandrel being encircled by an initially retracted soft elastomer sleeve **201** fitting within the copper sleeve or bushing **105***a*. A cylinder **202** bears against the upper end **60** of the drill bit and has its lower internal diameter **203** closely conforming to the outside diameter of the elastomer expander member **201**. The inner wall **204** of the cylinder above its lower portion is laterally spaced from the periphery **205** of the mandrel to provide an annular space in which a hard rubber sleeve **206** is inserted that bears against the upper end of the soft rubber sleeve **201**. An annular piston **207** is received within the annular space and bears against the upper end of the hard rubber sleeve **206**.

The piston **207** is forced downwardly within the annular cylinder, shifting the hard rubber sleeve **206** downwardly and causing the latter to compress, shorten and deform the soft rubber sleeve **201**, which will expand the ductile sleeve **105***a* outwardly within the internal spaces between threads **101** and bring it into snug engagement with the thread flanks **108**, as well as against the root **109** and crest **106** of the threads, the sleeve thereby being pressed into intimate contact with the box threads **101** and assuming the configuration illustrated in FIGS. **7**, **1***b*, **2**. The removal of the endwise force on the piston **207** will cause the soft rubber sleeve **201** to inherently contract to its original shape, allowing the mandrel **200**, soft and hard rubber sleeves **201**, **206**, piston **207** and cylinder **202** to be removed from association with the bit D.

The threaded connection embodying the intervening malleable sleeve **105** can be used at other locations in impacting devices, to insure substantially uniform loading of the thread surfaces. As disclosed in FIGS. **4** and **5**, an impacting shaft **300** is provided between the source of impact blow or blows and the drill bit D, the latter being illustrated as being threadedly secured to the lower end of an impacting shaft or rod section **301**, there being an intervening malleable or ductile sleeve **105** between the pin and box threads **104**, **101**. This shaft section has an upper externally straight threaded section **302** threadedly received within a coupling **303**, which, in turn, is threaded onto the lower externally threaded portion **304** of an upper impact or rod section **305**, the lower end **306** of the upper section and the upper end **307** of the lower section being in contact with one another so as to transmit the hammer or impact blows therebetween. A ductile sleeve **105** is provided between the external and internal threads of the upper pin **304** and coupling sleeve **303**, as well as between the lower pin **302** and coupling sleeve **303**, to insure the uniform transmission of load between the external and internal thread surfaces, in the same manner as described above in connection with the operation of the ductile sleeve **105** between the external and internal anvil and bit threads **104**, **101**.

I claim:

1. In percussive drilling apparatus: a first impact member adapted to receive an impact blow; means for delivering repeated impact blows to said first impact member; a second impact member having means engaging the first impact member to receive the blow from the first impact member; and connecting means for threadedly securing said members to each other comprising a box having internal threads, a pin within said box and having external threads conforming to said internal threads, and a malleable sleeve between said pin and box threads in intimate contact with said pin and box threads to transmit load therebetween.

2. In drilling apparatus as defined in claim 1; said pin and box threads being straight threads.

3. In drilling apparatus as defined in claim 1; said pin and box threads being straight threads of divided pitch.

4. In drilling apparatus as defined in claim 1; the material of said malleable sleeve being copper.

5. In drilling apparatus as defined in claim 1; said malleable sleeve being a plating on at least one of said pin and box threads.

6. In drilling apparatus as defined in claim 1; said pin and box threads being straight threads; the material of said malleable sleeve being copper.

7. In percussive drilling apparatus: an anvil member adapted to receive an impact blow; means for delivering repeated impact blows to said anvil member; a bit member having means engaging said anvil member to receive the blow therefrom; said bit member having an end face for impacting against the bottom of a bore hole; and a threaded connection between said anvil and bit members comprising a box on one of said members having internal threads, a pin on the other of said members within said box and having external threads conforming to said internal threads, and a malleable sleeve between said pin and box threads in intimate contact with said pin and box threads to transmit load therebetween.

8. In drilling apparatus as defined in claim 7; said pin and box threads being straight threads.

9. In drilling apparatus as defined in claim 7; said pin and box threads being straight threads of divided pitch.

10. In drilling apparatus as defined in claim 7; said box being on said bit member and said pin being on said anvil member.

11. In drilling apparatus as defined in claim 7; said box being on said bit member and said pin being on said anvil member; said pin and box threads being straight threads.

12. In drilling apparatus as defined in claim 7; said box being on said bit member and said pin being on said anvil member; the engagement between said anvil and bit members being between the lower end of said anvil member and the lower end of said box.

13. In drilling apparatus as defined in claim 7; the material of said malleable sleeve being copper.

14. In percussive drilling apparatus: a first rod member adapted to receive an impact blow; means for delivering repeated impact blows to said first rod member; a second rod member in endwise engagement with said first rod member to receive the blow therefrom; and connecting means securing said members together comprising a coupling sleeve having internal threads and surrounding the adjacent portions of said members, said adjacent portions having external threads conforming to the internal threads of said coupling sleeve, and malleable sleeve means between and in intimate contact with said internal threads and the external threads of said adjacent portions to transmit load therebetween.

15. In drilling apparatus as defined in claim 14; said internal and external threads being straight threads.

16. In drilling apparatus as defined in claim 14; said internal and external threads being straight threads; the material of said malleable sleeve means being copper.

17. In drilling apparatus as defined in claim 14; said internal and external threads being straight threads; said malleable sleeve means being a plating on at least one of said internal and external threads.

18. A percussive drill bit having a thread portion adapted to be threadedly secured to an impact anvil, said bit having an end face for impacting against the bottom of a bore hole and a face adapted to be engaged by the impact anvil to receive blows therefrom, and a malleable sleeve on said thread portion in intimate surface contact with the threads of such portion.

19. A percussive drill bit as defined in claim 18; said thread portion being an internal thread portion.

20. A percussive drill bit as defined in claim 18; said malleable sleeve being a copper sleeve.

21. A percussive drill bit as defined in claim 18; said thread portion being an internal portion; said malleable sleeve being a copper sleeve.

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