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GUN PERFORATOR

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The invention relates to a means and method of sealing instruments or equipment run into a well bore, or subjected to fluid pressures, so as to prevent leakage and may be particularly adapted for use to seal the powder charge and the connection between the various sections of a gun perforator.

Gun perforators are employed in the completion of wells where the well is drilled, the casing is set and the casing is then perforated at the elevation of the formations from which it is desired to produce a fluid. Such a perforator of necessity must be relatively small in diameter so as to be passed down into and removed from the well bore on the one hand, but must be constructed so as to have sufficient fire power to cause the projectile or bullet to penetrate the steel casing and usually a layer of cement which encloses the casing. When it is considered that a maximum diameter of about six inches is possible it seems obvious that a considerable charge of powder is required to propel the bullet. One of the particular problems encountered, however, is that the powder charge must be kept dry and sealed against the infiltration of fluid while the gun is being lowered into position in the well bore and it will be remembered that the well bore is filled with liquid which is usually a drilling fluid having a specific gravity 1.3 to as high as a specific gravity of 2. When it is further considered that well bores are now being drilled to approximately three miles in depth it will be appreciated that a column of liquid of such a depth will create a tremendous static pressure in the bottom of the well bore. The presence of this liquid in the well bore is necessary during the perforating operation because when the casing is perforated if the formation pressure should predominate over the static pressure of the liquid in the well bore, the well would blow out.

The operator of a gun perforator therefore is confronted with a problem whereby the powder charge must be sealed against pressures as high as ten thousand pounds per square inch. With pressure of this magnitude it is difficult to maintain a seal between the threaded connections of the various sections on the one hand and to prevent the leakage of fluid into the gun bore and the powder charge on the other hand.

Various expedients have been used in an attempt to seal these areas, but the present invention contemplates that a resilient covering will be provided over the connections and the gun bore, which covering will have sufficient resiliency to flow under pressure into the tiny crev-

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ices or connections when it is subjected to the tremendous external pressure and that due to the resiliency of the covering to which the external pressure is applied, that the sealing effect obtained will be a function of the pressure because the greater the pressure applied the greater will be the tendency of the resilient material to form a seal.

It is therefore one of the objects of the invention to provide a resilient seal or covering for the connections of a gun perforator.

Another object of the invention is to provide a resilient covering for the joint connections between the adjacent sections of a gun perforator assembly.

Another object of the invention is to provide a patch or sealing member to cover the gun bore of a gun perforator.

Still another object of the invention is to recess the periphery of a gun perforator so as to accommodate a resilient sealing member in such recessed area so as to prevent leakage into the gun bore or connection.

Still another object of the invention is to provide a resilient covering for the bore of gun perforators which covering can be adhesively affixed and the sealing thereof initiated by either heat or pressure or both and then the final sealing is accomplished by the external pressure to which the gun perforator is subjected at the well temperature.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawings wherein:

Fig. 1 is a vertical sectional view illustrating the assembled sections of a gun perforator to which the sealing members have been applied both to the connection and to the gun bores.

Fig. 2 is a section taken on the line 2—2 of Fig. 1 and illustrating the sealing band about the section connections.

Fig. 3 is a side elevation of one of the gun bores of the lower section of Fig. 1 just before the sealing patch or member is applied.

In Fig. 1 the gun perforator 2 is made up of a plurality of sections such as 3 and 4 which are threaded together by the threaded box connection 5, which is arranged to receive the threaded pin 6 on the next adjacent section. When these pins and boxes are threaded together, the complementary shoulders 7 on the sections 3 and 4 are arranged to engage each other and it is intended that they will form a seal between the sections. In actual practice, however, it has been

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found that when the gun perforator is subjected to the pressures encountered in a well bore, that there is some leakage through the shoulder structure 7 and along the threads so that in many instances liquid succeeds in leaking into the central area 8 by which the powder charges are ignited. This central area is in the form of a circular recess 9 in each of the sections which serve to form a continuous passage between the ignition passages 10 and 11 respectively in the two adjacent sections. Either a powder charge or an electrical circuit may be contained in these passages so as to ignite the powder charge in the gun portion of the various sections.

In order to prevent such leakage each one of the sections has been recessed adjacent its end as at 12 so that when the two sections are made up they provide between them an annular groove or depression 13. A band of rubber or other resilient material 14 is shown as having been stretched and positioned in this groove 13. If desired a suitable adhesive may be used to hold the band firmly in position. Certain adhesives which take a set when subjected to heat or pressure or both may be applied at the surface and the well pressure and temperature will thus insure the seal as such pressures and temperatures increase in the well. This band will be of suitable consistency such that when it is subjected to the tremendous pressure in the well bore that if the joint 7 provides a tiny crevice into which the resilient material may flow that the external pressure on the material will cause it to seep into the crevice and facilitate the formation of a seal. The outer periphery 15 of the band will, of course, be exposed to the pressure in the well bore and this in turn will cause the inner periphery 16 to form a seal with the surface 12 which is proportional to the externally applied pressure.

In this manner the greater the pressure and the heat being applied the greater will be the sealing effect being obtained. It seems obvious that these bands can be readily removed or destroyed by merely uncoupling the sections after the tool is removed from the well. A new band or ring can be provided each time the tool is used.

In the section 3 the lateral or transverse gun bores 20 have been provided. Each of these bores is arranged to receive a powder charge 21 in the base thereof which charge is ignited by a suitable flash travelling in the passage 10 passing into the recess 22. A bullet 24 is shown as having been inserted in each of the gun bores and it is, of course, the purpose of the present invention to form a seal over the mouth of the gun bore 20 so as to keep the powder 21 dry. To accomplish this sealing operation the periphery of the section has been recessed to provide a shoulder 25 upon which a supporting disc or plate 26 may be deposited. This disc or plate may be of metal, fiber or plastic so long as it is capable of supporting the load of the external pressure which is to be encountered. The periphery has also been recessed over a slightly larger area to provide a sealing shoulder 27 which is arranged to receive the cover or sealing plate member or disc 28. This member is of a resilient material such as rubber, synthetic, or plastic, which is adapted to flow when subjected to relatively high pressures. This disc or plate may be cemented or held in position by the application of a suitable adhesive prior to its insertion, but preferably it will fit snugly into the recess 27 and cover the joint which is formed by the plate 26 and its recess 25.

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When this assembly is subjected to the external pressure the pressure will be applied, of course, over the entire exposed surface of the cover 28 so that the cover will be forced back against its shoulder or recess 27 and against the outer surface of the support plate 26. If there is any tendency for leakage due to the applied pressure the resilient material will flow into the joint between the support disc and its recess 25 so as to block the crevice or connection formed thereby and prevent any further leakage. The sealing effect is therefore proportional to the applied pressure.

The lower section 4 shows a slightly different form of gun bore wherein a powder chamber 40 has been formed to receive the powder charge 21 and then the bore is enlarged somewhat and threaded as at 42 to receive a bushing 43 which carries the bullet 24. The gun barrel 41 is formed in the bushing 43. This bushing is recessed at 44 to receive the support plate 26 which has been previously described and the bushing is also reduced in external diameter adjacent its end to provide a flange 45 which is non-circular to facilitate its insertion and removal and which in turn is arranged to receive the lip 46 of the cover plate or member 47. This member 47 is in turn disposed in the recess 48 inwardly of the periphery.

With this construction the thread 42 is sealed by the cover plate as is the connection 49 between the support disc 26 and the bushing. The cover plate may be applied as heretofore described with adhesive. The external pressure applied to this cover plate forces it over the connecting areas to form a seal and it will grip into the connection to provide a seal if there is any tendency for leakage.

There is a tremendous safety feature in the use of the present invention because the support discs and patches may be applied without any substantial pressure as distinguished from the present practice of screwing in cover plates or like devices with pressures of as high as twenty thousand pounds per square inch. Several accidents have occurred due to explosions of the powder while loading the guns. If the support disc and patch are made of a plastic or material of lesser specific gravity than the well liquid, of course they will float to the surface with the circulating liquid. This avoids depositing metal plugs in the well when the gun is fired.

Broadly the invention contemplates a means and method for sealing tools, instruments and like devices such as gun perforators against leakage.

What is claimed is:

1. A gun perforator for wells comprising a plurality of sections, means to connect the sections, a lateral bore in each section, a powder charge and a bullet in each bore, means to ignite the powder charges of the several bores, and resilient means encircling the section joints and overlapping the connections, and a resilient patch overlying each of the bores whereby when the gun is subjected to the fluid pressure in a well bore the pressure forces such means into sealing position.

2. A gun perforator for wells comprising a plurality of sections, means to connect the sections, a lateral bore in each section, a powder charge and a bullet in each bore, means to ignite the powder charges of the several bores, and resilient means encircling the section joints and overlapping the connections, and a resilient patch overlying each of the bores whereby when the

gun is subjected to the fluid pressure in a well bore the pressure forces such means into sealing position, said means being sufficiently resilient to flow under such pressure into any open areas thereunder to facilitate sealing.

3. A gun perforator comprising a plurality of sections, threaded areas on the ends of adjacent sections for connection of the sections together, a shoulder on each section, and a ring or band of resilient material overlying the joint between assembled shoulders so that external pressure retains said band and facilitates the sealing of the connection.

4. A gun perforator comprising a plurality of sections, threaded areas on the ends of adjacent sections for connection of the sections together, a shoulder on each section, and a ring or band of resilient material overlying the joint between assembled shoulders so that external pressure retains said band and facilitates the sealing of the connection, said sections being recessed to receive said band.

5. A gun perforator section comprising a body, a lateral bore therein, a powder charge and a bullet in said bore, a closure for said bore disposed inwardly from the end to provide a recess, and a resilient sealing disc disposed within said recess and within the contour of said body to seal the joint between said closure and body, said disc being of a material to flow under external pressure so that a seal is formed as a function of such pressure.

6. A gun perforator section comprising a cylindrical body, a lateral bore therein, a powder charge and bullet in said bore, and means to seal the bore to prevent the entrance of fluid from the exterior comprising a support plate and a sealing member thereover, said sealing member being a relatively thin resilient patch overlying the joint between said plate and bore and adapted to flow under external pressure so that the seal is formed as a function of the pressure, said section being recessed about the entrance to the bore to receive said support plate and said member.

7. A gun perforator comprising a gun section, a gun bore therein, and means to seal the outer end of the bore against fluid pressure leakage to the interior comprising a support member of a size to close the bore, and a resilient sealing disc only slightly larger than said support member disposed on said member and adapted to seal the joint about said member and the gun section.

8. A gun perforator comprising a gun section, a gun bore therein, and means to seal the outer end of the bore against fluid pressure leakage to the interior comprising a support member to close the bore, and a resilient sealing patch disposed on said member and adapted to seal the joint about said member and the gun section, said bore including an inserted bushing comprising the gun bore.

9. A sealing assembly for gun perforator barrels comprising a support disc fitted over the end of the barrel and a sealing member fitted over and only slightly larger than said support disc whereby when the perforator is subjected to external fluid pressure said sealing member will be forced against support disc to seal the joint between the member and the bore.

10. A sealing assembly for gun perforator barrels comprising a support member fitted over the end of the barrel, and a sealing member fitted over said support member whereby when the perforator is subjected to external fluid pressure said

sealing member will be forced against support member to seal the bore, said barrel including an insert bushing with said support member disposed thereagainst and said sealing member covering the joint between the bushing and perforator and the joint between the bushing and support member.

11. A sealing assembly for gun perforator barrels comprising a support member fitted over the end of the barrel, and a sealing member fitted over said support member whereby when the perforator is subjected to external fluid pressure said sealing member will be forced against said support member to seal the bore, said sealing member being countersunk in the surface of the perforator.

12. A seal for gun perforator barrels comprising a resilient disc fitted over and only slightly larger than the outer end of the gun barrel, said disc being adapted to flow so that external pressure on the gun perforator exerted against said disc will maintain the barrel sealed.

13. A seal for gun perforator barrels comprising a resilient disc fitted over and only slightly larger than the outer end of the gun barrel, said disc being adapted to flow so that external pressure on the gun barrel exerted against said disc will maintain the barrel sealed, and an adhesive material for retaining said disc.

14. A method of maintaining the firing charge of gun perforators in a dry condition while the perforator is exposed to fluid under pressure in a well bore, comprising sealing the outer end of the barrel with a resilient covering only slightly larger than the area of the barrel, such covering being of a consistency which will flow against the perforator body and the barrel to fill any crevice or joint connection thereunder to prevent leakage of the liquid under pressure into the barrel.

15. A sealing assembly for well tools having a threaded connection between the parts subjected to external pressure comprising, a recessed area at said connection, and a covering of resilient material overlying the connection, said material being relatively thin and adapted to flow against the connection under well pressures to seal.

16. A seal for gun perforator barrels comprising a disc to fit into the end of the barrel, a patch of resilient material overlying and only slightly larger than said disc, said patch being of a material adapted to flow under well pressures and sealing the joint between the disc and the perforator barrel.

17. A seal for gun perforator barrels comprising a disc to fit in the end of the barrel, a patch of resilient material overlying said disc and sealing the joint between the disc and perforator, said disc being of a material which floats in the well drilling fluid so as to be circulated out of the well bore.

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