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METHOD AND APPARATUS FOR CLOSING AND SEALING OPENINGS IN A WELL CASING

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FIG. 4

FIG. 5

FIG. 6

FIG. 8

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This invention relates broadly to the treating of wells and more specifically to a method and apparatus for closing and sealing openings in the casing of a well.

In the drilling of oil or gas wells, the log or results obtained from various tests might seem to indicate that the particular site under consideration could readily have a plurality of producing zones. In such a situation, the problem arises concerning the treating of one zone and then sealing or isolating said zone in order to undertake the treatment of another zone, which second zone would then be isolated or sealed in order to permit the treating of any additional zones. While the closing or sealing off of one area or zone in order to undertake the treating of an adjacent area in a multi-zone operation does not, in and of itself, constitute the only problem confronting the operator, it can and usually does present one of the major problems that is to be encountered in such a drilling operation.

In present day operations, a production string of tubing or casing is set in the customary manner and then subjected to a perforating operation by bullets, chemical charges or similar devices for producing apertures or openings in the tubing or casing at the level wherein the bearing strata is believed to lie. The apertures or openings in the tubing or casing permit the bearing strata or productive zone to be subjected to a stimulation treatment, such as by hydraulic fracturing, whereby fluid containing sand and other additives is injected into said strata or zone in order to rupture the zone and form passages therein while maintaining said passageways in a substantially open or porous state through which the oil or gas in the strata or zone may then escape into the tubing or casing.

While the use of packers, plugs, and the like have been successfully employed in multi-zone operations, for the purpose of isolating or separating one zone from the next, the removal of said plugs, packers and the like have in many instances presented certain problems. The cost of the entire drilling operation can be materially increased in the event that difficulty is encountered in effecting the removal of said plugs, packers or the like. The use of balls or spheres for the purpose of sealing the openings or apertures formed in the tubing or casing of the well have proven to be quite effective in recent years. In fact, the use of said balls or spheres for closing the well casing apertures or openings has tended to supplant the use of plugs, packers and the like as means have been devised to effect the recovery of said balls or spheres with a minimum of effort and expense so that a treated zone that has subsequently been sealed off by said balls or spheres may very easily be brought into operation as a producing zone.

It has been determined, however, that the use of balls or spheres will not effectively seal the well casing apertures when said openings or apertures are of irregular configuration. Such irregular openings or apertures can occur as a result of a perforating action causing the tubing or casing to split or by sand groves being formed in the edges of the holes or apertures as a result of the hydraulic fracturing operation or stimulation treatment. Thus, it becomes quite difficult to effectively close and seal a casing area having irregular openings or splits formed therein or grooves formed in the edges of said openings or apertures through the use of spherical sealant means as in many instances, the spherical sealant means would simply be forced through the apertures or openings.

The present invention is intended to overcome the various shortcomings found to exist in prior devices, particularly as concerns a sealant member that is capable of effectively sealing not only perforations but also slits, ruptures, and openings or apertures of irregular configuration in a well casing or tubing. In addition, the present invention is directed to means for delivering the sealant member to a desired zone in a well casing and effectively placing said sealant member in engagement with the casing to positively seal the perforated area regardless of the type of openings or apertures formed in the casing.

In the present invention, the sealant member is lowered in a well casing to the perforated zone by means of a transporter which is under the control of an operator at all times. When the transporter has been lowered to the desired level, the sealant member is effectively removed therefrom while being retained within the well casing at the desired level so that as it is being removed from the transporter, it is permitted to move into engagement with the perforated zone of the casing for effectively sealing same. The sealant member is provided with means which permit its ready removal from the well casing so that the treated area may then be brought into operation as a producing zone.

One of the objects of the present invention is to provide a novel method and apparatus of introducing into a perforated well casing a unitary sealant member for engaging and effectively sealing the perforations in said casing.

Another object is to provide a transporter having a unitary sealant member therein which is delivered to a perforated area or zone of a well casing with means to effect the removal of the sealant member from the transporter for engaging the well casing to effectively seal the perforated area or zone.

Another object is to provide a unitary sealant member formed from a resilient material and being of elongated tubular configuration for engaging the walls of a tubing or casing as an interliner thereof.

Another object is to provide a transporter tube and a unitary resilient sealant member of elongated tubular configuration and having a normal external diameter greater than the internal diameter of the transporter wherein said sealant member is crimped or compressed along one longitudinal portion to produce a buckled section and reduce the diameter of the sealant members to facilitate its positioning within the transporter tube.

Still another object is to provide a unitary resilient sealant member of elongated tubular configuration that is capable of being crimped or compressed along its longitudinal axis to facilitate its movement into a well tubing or casing and which is capable of returning to its normal condition within said tubing or casing for effectively engaging the casing to seal a perforated zone or area.

A further object is to provide a unitary resilient sealant member of elongated tubular configuration that is introduced into a well tubing or casing to effectively seal a perforated zone and wherein said sealant member is provided with suitable elements at one end thereof which facilitate the ready removal of said sealant member from said well tubing or casing.

A still further object is to provide a unitary sealant member with resilient means connected to one end thereof and engageable with a well tubing or casing for effectively placing and maintaining said sealant member within said tubing or casing.

Other objects and advantages, more or less ancillary to the foregoing in the manner in which all of the various
objects are realized, will appear in the following descrip-
tion, which, when considered in connection with the ac-
companying drawings, sets forth the preferred embodi-
ment of the invention:

Referring to the drawings wherein the preferred em-
bodyment of the invention is illustrated:

FIGURE 1 is a vertical sectional view of a cased earth well showing the casing perforated at a fractured zone and illustrating conventional well head equipment;

FIGURE 2 is an enlarged vertical sectional view of a portion of the casing of the well of FIGURE 1 showing a transporter used for positioning a casing interliner therein;

FIGURE 3 is an enlarged vertical sectional view similar to FIGURE 2 and showing a portion of the transporter and a casing interliner sealant member in position over the perforations at a fractured zone;

FIGURE 4 is an enlarged detailed sectional view of the lower end of the transporter stem and its connection to the upper end of the transporter shell as shown in FIGURE 2;

FIGURE 5 is an enlarged detail view showing the connection between the transporter stem and the transporter shell at one stage of the operation;

FIGURE 6 is an enlarged detailed sectional view show-
ing the lower end of the transporter stem and the upper portion of the transporter shell at another stage of the operation;

FIGURE 7 is an enlarged detailed sectional view show-
ing the casing interliner sealant member being removed from the transporter shell;

FIGURE 8 is an enlarged cross sectional view show-
ing in detail the manner in which the casing interliner sealant member is positioned within the transporter shell, the view being taken on the line 6—6 of FIGURE 7;

FIGURE 9 is a cross sectional view showing a portion of the spring cage tension member carried by the lower end of the casing interliner sealant member, the view being taken on the line 9—9 of FIGURE 7;

FIGURE 10 is a vertical sectional view of a detailed element of the spring cage tension or positioning mem-
er, the view being taken on the line 10—10 of FIG-
URE 9;

FIGURE 11 is a detailed view of another portion of the spring cage tension or positioning member, the view being taken on the line 11—11 of FIGURE 9;

FIGURE 12 is an enlarged detailed sectional view show-
ing the lower portion of a grab tool prior to its engagement with the retrieving or grab members mounted in the casing interliner sealant member; and

FIGURE 13 is an enlarged detailed sectional view show-
ing the grab tool in engagement with the casing interliner sealant member for removing same from the well casing.

Referring to FIGURE 1 of the drawings, there is shown a conventional well bore having disposed therein the usual outer or surface casing 20 which has mounted therein, in the customary manner, an inside or produc-
tion casing string 21 upon which is mounted a control valve 22. The production casing string 21 extends through the various formations in the well bore and terminates at the end or bottom of said bore. The control valve 22 has connected thereto a well head assembly or unit 23 that has supported thereon a well head lubricator or launch tube assembly by which the well is maintained in locked internal control regardless of pressures generated within the bore. The well head lubricator or launch tube assembly does not, in and of itself, constitute a part of the present invention, but same is employed in a multi-
zone operation wherein it is necessary and essential to introduce into the casing 21 various types of equipment or apparatus and it is essential that the pressure be maintained within the well bore at all times that such apparatus or equipment is being either introduced or re-
moved therefrom.

As concerns the present invention, it would be suffi-
cient to state that the well head lubricator or launch tube assembly mounted on the well head unit 23 is provided with a cross head structure that communicates with a well bore 25. The cross head has supported thereon in operative rela-
tion therewith a launch tube control valve 26, which in turn, supports a launch tube 27 that is provided with a quick coupling 28 to facilitate its ready attachment or detachment from the control valve 26 so that various pieces of apparatus or equipment may be either inserted into the launch tube or removed therefrom. It is through the use of the valves 22 and 26 that the pressure within the well bore may be maintained and also introduced into the launch tube so that the pressure within the launch tube will be equal to the well bore pressure and thus, pro-
vide a balanced condition prior to the lowering of equip-
ment or apparatus into the well bore. The inner or pro-
duction casing string 21 is shown, FIGURE 1, as extend-
ing through what are considered to be, based upon data obtained from previous tests, two potential producing formations A and B and furthermore, the casing or string has been anchored or secured in place by a conventional cement sheath 29. In addition, casing 21 has been perfo-
rated at formation A and said formation has been stimu-
lated by subjecting same to hydraulic fracturing whereby passageways have been created or developed in said for-
mation through which the oil or gas may readily flow or pass to the well bore and thence through the perforations into the casing or production string 21. Thus, it becomes necessary to close or seal the perforations 30 in the cas-
ing 21 opposite zone A before it is at all appropriate or staggered to operate perforating or opening operations within the well bore, and subject this zone to a stimulation treatment through hydraulic frac-
turing. This is by way of illustration, representative of openings or apertures that have be-
come enlarged or irregular in configuration and thus in-
compatible of being closed by spherical or ball type sealant members as said types of sealant members would either pass through the perforations 30 in the casing 21 or be so lodged therein that said opening would not be efect-
ively sealed. As pointed out above, the perforations 30 can readily result in splits or elongated ruptures being formed in the casing string so that to effectively seal the perforations or apertures, in order to move the operation to another zone, it is essential that a casing interliner seal-
ant member be employed which would overlie the perfor-
rated area of zone A for effectively sealing or closing the perforations before commencing perforation operations in zone B.

There is shown in FIGURE 2 an assembly for lower-
ing a unitary sealant member from the well head assembly 23 through the casing string 21 by means of a con-
ventional wire line 33. The assembly includes an elon-
gated cylindrical stem member 34 that is preferably formed from solid metal to provide the necessary weight to effectively lower the sealant member within the casing string. The stem member 34 terminates, at its uppermost end, in a tapered wire line socket 35 that may be formed integrally therewith or as a separate element that may be secured thereto by any suitable means. The wire line socket 35 is securely fastened to the wire line 33 to per-
mit the lowering of the sealant member through the casing string 21. As shown in FIGURES 4 through 6, the lower end of the stem member 34 is formed with a socket 36, which is internally threaded at its outermost end portion to receive the reduced threaded end portion of a plug member 37. The socket 36 has slidably disposed therein a piston 38 which has a depending piston rod 39 and is elongated to engage with the internal portion of the end portion as well as the body of the plug member 37. The piston 38 has projections 40 formed on its outer surface, at diametrically disposed points, which are adapted to move in guideways 41 formed in the socket 36 so as to permit the piston to have a longi-
tudinal reciprocating motion within said socket but pre-
vent any rotative movement of the piston independent of the stem member 34. The lowermost end of the piston rod 39 is threaded for engagement within a socket formed in the tapered upper end of a ball shaped adapter member 43. The large or mouth end of the adapter is provided with suitable threads for securing the adapter member 43 to the upper end of a transport tube or carrying member 44, FIGURES 2 and 7. The adapter 43 is provided with a plurality of spaced openings 45 to permit the passage of fluid into and out of the transport tube or carrying member 44 as it is being lowered in the casing string 21. The transport tube 44 is of cylindrical configuration and can be of any desired length dependent upon the length of the unitary sealant member or casing interliner 46, FIGURES 3 and 7, that is to be placed within the zone A of the casing string 21. The unitary sealant member 46 is of tubular configuration and preferably formed of high-strength rubber or some suitable resilient composition which would be sufficiently flexible so that said sealant member could easily expand against the wall of the casing string 21, or even against the wall of a bore if same is used without a casing string, when reasonable pressure is applied to the well bore. The unitary sealant member has an external diameter such that it will conform closely to the drift size of the tubing or casing string 21, if used, thus, the external diameter of the unitary sealant member is in the majority of instances greater than the internal diameter of the transport tube or carrying member 44. Therefore, in order to position the unitary sealant member 46 within the transport tube 44, the sealant member is, due to its flexibility, crimped and compressed on one side from one end to the other by forcing this portion of the sealant member inwardly towards its diametrically opposite side to form a buckled portion or segment 50, FIGURE 8. The sealant member is retained in this buckled or cramped condition by securing same at spaced points throughout its length with suitable binding strings 47, FIGURES 7 and 8, which will readily permit the sealant member to be inserted into the transport tube 44 from its lowermost end and pushed upwardly to a position adjacent the adapter member 43.

The unitary sealant member or casing interliner 46 has been embedded in its uppermost end and projecting therefrom a plurality of grabbing prongs 48, which are spaced from one another around the upper end of the sealant member and preferably are vulcanized to said sealant member. The prongs 48 have secured thereto or formed integrally therewith reinforcing wires 49 secured thereto throughout the length of the sealant member 46 and which may be vulcanized inside of the wall or suitably secured to the inner surface of the sealant member. The free ends of the prongs 48 terminate in down-turned ends 50 that define hook members, FIGURE 7, the use of which will be described hereinafter. Certain of the wires 49 have secured thereto, at the lower end of the sealant member 46, suitable bead chains 52, FIGURE 7, which are connected to a ring member 53 that is in turn connected to a second or lower ring member 54 by a plurality of tension bolts 55, FIGURE 10. The ring members 53 and 54 are retained in spaced parallel relation with one another by means of a plurality of relatively flat spring members 56 which have their ends secured to said ring members with the central portion thereof bowed outwardly so as to engage the inner surface of the casing string 21, FIGURE 7. Thus, the ring members 53 and 54 and spring members 56 tend to constitute a spring tension cage depending from the casing interliner 46 and which is adapted to engage the casing string or the well bore wall for positioning and retaining the interliner therein. As shown in FIGURE 11, the bead chains 52 extend through aperture like sockets 57 formed in the ring member 53 and are retained in position with respect to said ring member by an enlarged disc member 58 that overlies the socket 57. The disc member 58 has secured thereto a coil spring 59 which is anchored to the lower ring members 53 and 54 to the bead chain 52. The ring members 53 and 54 are strongly formed with outside and inside diameters commensurate with those of the sealant member 46 to permit the ready passage of tools and equipment through the sealant member 46 and also through the spring cage assembly as defined by ring members 53 and 54.

The lower end of the transporter tube 44 has formed on the inner surface thereof, FIGURE 7, a projection or sleeve 62 in which is slidably mounted an arm or rod 63. The upper or innermost end of the arm 63 is formed with an angularly offset portion 64 that prevents the removal of the arm from the sleeve 62, while the lower end of the arm has detachably secured thereto a socket member 65 which has pivotally connected to the lower end thereof a knife blade 66. The socket member 65 has one end of spring member 67 secured thereto while the other end of the spring is affixed to the knife blade 66 for maintaining the blade in spring tension at all times.

The piston rod 39, FIGURES 4 through 6, is formed with a recess or indentation 69 superjacent its threaded connection with the upper end portion of the adapter member 43. The recess 69 is in communication with a transverse passage or bore 70 formed in the piston rod 39, through which extends a suitable anchor string or wire 71 with one end of said string being secured in any suitable means within the recess 69. The upper end of the adapter member 43, contiguous its threaded connection with the lower end of the piston rod 39 is provided with a vertical passageway 72 for the reception of the anchor string or wire 71 so that said anchor string may be attached to said sealant member 46 by being secured to the piston rod 39 and the sealant member 46 not only insures the retention of the sealant member within the transporter tube 44 during the time that they are being lowered in the casing string 21 but also retains the sealant member within the transport tube and overcomes the drag resistance of the spring tension cage unit in the event that the transport tube has to be withdrawn from the casing string 21. The upper end portion of the adapter member 43 is provided on its outer face with a recess 74 within which is secured one end of a spring arm 75. The free end of the spring arm 75 has secured thereto a knife assembly which consists of an arcuate-shaped blade member 76 that has mounted on its outer surface a vertically extending web segment 77 that is affixed to the spring arm 75. The configuration of the web segment of the plug member 37 is such as to engage the outer face of the plug member 37, FIGURE 4, but in its operative position, will engage the outer surface of the piston rod 39, FIGURE 5. The lowermost end portion of the spring member 34 has secured thereto, by any suitable means, one end of an accordion type resilient sleeve 79, with the other end of said sleeve being secured to the upper end of the adapter member 43. Thus, the plug member 37, spring arm 75 and knife member 76 are enclosed within said sleeve 79 which prevents the passage of any foreign matter, such as sand or the like, into the area of said plug member and piston rod.

In the use and operation of the unitary sealant member or casing interliner of the present invention, it can be assumed that the well has been drilled, the casing run and cemented in place followed by a perforating and a hydraulic fracturing or stimulating operation of the zone A. Upon the completion of the hydraulic treatment, the casing perforations in zone A have to be sealed so that the next zone, such as zone 81, can be subjected to a perforating operation, a hydraulic or stimulating treatment and then the sealing or closing of the perforations in this zone so that another zone may be treated. As pointed out above, the openings or apertures in the well casing can
readily become enlarged during the hydraulic or stimulating treatment so that known types of sealant members are incapable of effectively closing said openings to permit an operation to be undertaken within the next adjacent sealant member or casing interliner of the present invention is thus readily adaptable to effectively seal perforations of irregular size and configuration formed in a well casing as well as casing perforations that might be considered of normal size and configuration. It should, therefore, be understood that the use of a casing member or casing interliner is readily adaptable for use in sealing openings of various and sundry sizes and configurations in a well casing as well as being capable of sealing a formation face or productive zone in a well bore open hole.

The resilient sealant member or casing interliner can be of various lengths and is preferably formed from any suitable resilient material that would permit said sealant member to expand to a degree from its normal position for effectively engaging the sides of the well casing and be retained in said expanded or normal position by the pressure within said casing. The casing interliner is preferably formed of a resilient material such as rubber and is internally reinforced throughout its length by suitable components or elements or connecting wires, that terminate at one end of the casing interliner in grab hooks while at the opposite end, they are connected to the casing interliner, due to its flexibility, is readily capable of being compressed or cramped on a longitudinal plane from one end to the other so as to form a buckle portion FIGURE 8, which is retained in this position while being bound at spaced points throughout its length with binding strings. The connecting wires are so disposed within the casing interliner and connected at the ends thereof as to not interfere with the compressing or crimping of the interliner and the subsequent securing of the interliner in its buckled position by means of the binding strings. After the casing interliner has been secured in its buckled or cramped or crimped condition, the tension spring cage that is secured to and carried by the bead chains is readily adjusted by the tension bolts moving the ring member with respect to the ring member whereby the side pressure that is exerted by the spring members against the well casing can be preset dependent upon the diameter of said casing. In order to insert the bound or buckled casing interliner into the transport tube, the knife blade and socket member are removed from the lower end of the casing interliner, and the casing interliner is then positioned within the transport tube so that the channel is defined or formed by the buckle is disposed in spaced aligned relation with the arm, FIGURES 7 and 8. After the casing interliner is positioned almost entirely within the transport tube, the socket 65 and knife blade 66 are secured to the arm 63 so that the spring loaded knife blade is arranged to project outwardly at an angle from the socket end and extend into the area of the channel 81 to point contiguous to the casing interliner and thus underlie all of the binding strings, FIGURE 8. Prior to inserting the casing interliner into the transport tube, the resilient accordion type sleeve 79, FIGURES 4 through 6, is removed from the adapter member 43 so that said adapter member may be unsecured from the lower end of the piston rod 39, to permit the piston rod to project below the plug member 37 and expose the recess 69. With the piston rod so positioned, one end of the anchor wire string 71 is secured within the recess 69 and then threaded through the bore 70, after which the free end of the anchor string or wire is fed through the vertical passageway 72 in the adapter member 43 which member is then secured to the piston rod and the resilient sleeve 79 is returned to its initial position. The casing interliner 46 having been positioned within the transport tube 44, the anchor wire or string 71 is then secured to the upper end of the casing interliner in any suitable manner which insures the retention of the casing interliner within the transporter tube and prevents same from sliding out of or being inadvertently withdrawn from the transporter tube. The transporter tube having been so loaded is then ready for a down hole bore run to position the casing interliner within the desired area of the well casing, such as zone A, and as the transporter tube 44 and the cylindrical stem member 34 bearing means of the wire line 33, the tension spring cage member, with the flat spring members 56 slidably engaging the inner surface of the casing wall, is being pushed downwardly by the weight of said stem member. Inasmuch as the transporter tube is of a diameter closely approximating that of the casing string 21 any fluid contained within said casing string is capable of flowing upwardly through the casing interliner and out through the openings in the adapter member 43 and on up and around the stem member 34 so that the transporter tube with the casing interliner and tension spring cage will not be impeded in its down hole run.

The transporter tube having reached the desired location within the casing string 21, the tension spring cage assembly through its engagement with the inner surface of the casing string 21 as well as the anchor string 71 will prevent any further movement of the casing interliner independently of the transporter tube and stem member 34. During the time that the transporter tube 44 is being lowered in the casing 21, the plug member 37 is retained in abutting engagement with the upper end of the adapter member 43 so that the knife member 63 is resting on the outer peripheral face of the plug member 37 while the piston 38 is retained in the upper portion of the socket 36, FIGURE 4. It is through the foregoing arrangement of parts that the weight of the stem member 34 is transmitted to the transporter tube 44 to facilitate the down hole run of said transporter tube, and the various parts will be retained in said relationship during this down hole run. In the event that the casing interliner and transporter tube have to be withdrawn from the casing 21 without positioning the casing interliner within said casing 21, the retraction of the wire line 33 will cause the stem member 34 to be elevated, thus, moving the plug 37 upwardly along the piston rod 39 until such time as it abuts the felt wiper ring 82, FIGURE 5, after which the transporter tube with the casing interliner therein may be withdrawn from the casing 21 due to the anchor wire or string 71 being connected to the lower end of the piston rod 39 and to the casing interliner 46 within the transporter tube 44. As long as this anchor string 71 remains in engagement with the casing interliner 46 and the piston rod 39, the tension drag of the spring members 56 on the casing 21 can be overcome so that the transporter tube can be withdrawn while still retaining the casing interliner therein. During this withdrawing action, the accordion sleeve 79 is extended in the manner as shown in FIGURE 5 and the elevation of the plug member 37 permits the spring arm 75 to move the knife member 76 into engagement with the peripheral surface of the piston rod 39. After the stem member 34 and transporter tube 44 have been withdrawn from the casing string 21, it will be necessary to remove the accordion sleeve 79 so that the spring arm 75 and knife member 76 may be moved outwardly to permit the plug member 37 to be lowered into abutting engagement with the upper end of the adapter member 43. At this time, the stem member 76 can then be moved into engagement with the outer surface of the plug member 37 and the sleeve 79 then placed over the outer surface of the adapter member 43, FIGURE 4.

Assuming that the transporter tube 44 has reached zone A with the tension spring cage unit positioned within the casing 21 at a point below the zone A, FIGURE 3, the stem member 34, under the control of the wire line 33, is then elevated a short distance so as to cause the plug mem-
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her 37 to be raised and brought into engagement with the piston 38 allowing the spring arm 37 to be raised and brought into engagement with the outer surface of the piston rod 39. When the knife member is positioned in engagement with the outer surface of the piston rod 39, the stem member 34 and plug member 37 are once again lowered, under the action of the wire line 33, so that the lower face of the plug member 37 will be brought into engagement with the web member 77 of the knife 76 causing the knife to move downwardly along the piston rod 39 and under the weight of the stem member 34 and plug member 37 to sever the anchor wire or string 71, FIGURE 6. The anchor wire having been severed, the stem member 34 and transporter tube 44 are then elevated by means of the wire line permitting the casing interliner to be withdrawn from the transporter tube as such as said casing interliner is now under the control of the tension spring cage unit. As the transporter tube is elevated and the casing interliner 46 withdrawn, the arm 63 will move downward in the sleeve 62 until such time as the offset portion 64 engages the sleeve 62. Thus, upon the continued elevation of the transporter tube 44, the spring-loaded knife blade 66 will then engage the binding strings 47 within the channel area 81 and sever or cut said strings as the transporter tube and knife blade are slowly elevated in the casing string 21. Thus, as the transporter tube 44 moves upwardly, all of the binding strings will be cut and the casing interliner will, due to the inherent flexibility of a return to its normal or original position and engage the inner surface of the casing string 21 to overlie the perforations in zone A, FIGURE 3.

The bore of the unitary sealant member 46 when in operative position within the casing string 21 should be at the maximum diameter possible in order to permit the passage of various tools and equipment through the sealant member. In addition, the diameter of the ring members 53 and 54 should also be maintained at a maximum dependent upon the diameter of the casing string 21 to facilitate the passage of tools and equipment therethrough as it may be readily be that under certain circumstances, in a multi-zone operation, it would be desirable to treat the uppermost zone and then seal this zone after which the lower zone could be perforated and treated by passing tools through the sealant member 46 and ring members 53 and 54, and then after the lower zone had been treated so as to make it a producing zone, the sealant member overlying the uppermost zone could be removed from the casing string 21 to permit both zones of the well to become productive.

In order to affect the removal of the casing interliner from the string 21, a grabbing or retrieving tool with accessory jars is conventionally lowered into the well to engage the interliner. The retrieving or grabbing tool, FIGURES 12 and 13, includes a cylindrical body portion 85 which is formed with suitable apertures 86 in the upper portion thereof to permit the passage of fluid there-through. The lower end of the body portion 85 terminates in an inwardly extending annular lip 86 that is disposed at a slight inclination with respect to the inner surface of the body portion 85 to define an annular groove 87. The lowest end of the body portion 85, subjacent the lip 86, is flared outwardly to define a bell mouth 88 which upon being lowered into the casing string 21, will move over the upper end portions of the grab prongs 48 and direct said prongs into the body portion 85 until the down turned ends 59 of said prongs move over the annular lip 86 and into the groove 87. With the prongs 48 so engaged by the annular lip 86 of the grabbing tool, the casing interliner may then be withdrawn from the casing string 21 overcoming the drag of the tension spring cage along the inner surface of the casing string 21. In order to more readily facilitate the removal of the casing interliner 46 from the casing string 21, a suitable mastic type surface lubricant could be applied to the outer surface of the casing interliner prior to its being crimped and placed within the transporter tube 44. Such a lubricant would not affect the sealing characteristics of the interliner but would tend to materially reduce friction between the interliner and the casing string when said interliner was being removed from said casing string.

Although the foregoing description is necessarily of a detailed character, in order that the invention may be completely set forth, it is to be understood that the specific terminology is not intended to be restrictive or confining, and that various rearrangements or parts and modifications of detail may be resorted to without departing from the scope or spirit of the invention as herein claimed.

I claim:

1. Apparatus for temporarily sealing apertures formed in the casing of a well comprising a carrying member, means connected to said carrying member for lowering and raising said member within said casing, an elongated tubular sealant member of uniform diameter throughout its length positioned within said carrying member for lowering and raising same in said casing, an elongated tubular sealant member of uniform diameter throughout its length positioned within said carrying member for lowering and raising same in said casing, and a spring cage unit connected to said carrying member for lowering and raising said member within said casing, all of such character and means as to accomplish the object and purpose of the invention

2. Apparatus as set forth in claim 1 in which said sealant member is resilient and has an external diameter greater than the internal diameter of said carrying member.

3. Apparatus as set forth in claim 1 in which said sealant member includes a pair of spaced ring members having a plurality of flexible members connected thereto for engaging the well casing.

4. Apparatus as set forth in claim 2 in which a portion of said sealant member is crimped throughout its length to reduce its external diameter and facilitate its positioning within said carrying member.

5. A unitary sealant member for a well casing comprising an elongated resilient tubular member having a normal diameter that is reduced when a portion of said tubular member is compressed throughout its length, a plurality of reinforcing elements secured to said tubular member, a plurality of flexible members connected to certain of said reinforcing members at one end of said tubular member and adjustable tension unit connected to said flexible members.

6. A unitary sealant member as set forth in claim 5 wherein said reinforcing elements project outwardly from an end of said tubular member and terminate in bent end portions.

7. A unitary sealant member as set forth in claim 5 in which said tension unit includes a pair of ring members arranged in spaced relation to one another subjacent the tubular member.

8. A unitary sealant member as set forth in claim 7 in which said ring members have a plurality of spring members interposed between and connected thereto with means engaging said ring members to vary the tension of said spring members.

9. Apparatus for temporarily sealing the apertures formed in the casing of a well comprising a transporting tube, an elongated tubular sealant member formed of a resilient material and having a normal external diameter greater than the internal diameter of said tube, a portion of said sealant member being crimped inwardly throughout its length toward its diametrically disposed portion, securing means attached to said crimped sealant member to facilitate its insertion into said transporting tube, anchor means carried by said transporting tube for retaining said crimped sealant member therein, a spring cage unit connected to said sealant member subjacent said
transporter tube, means connected to said transporter for lowering same within said casing and positioning said spring cage in engagement with the casing below the area of the apertures, means carried by said transporter tube for releasing said anchor means and permitting the raising of said transporter tube within said casing to position said sealant member in the area of said apertures and knife means carried by said transporter tube for severing said securing means and allowing said sealant member to expand into engagement with said casing.

10. Apparatus as set forth in claim 9 wherein said sealant member is formed with spaced reinforcing members extending throughout its length with said reinforcing members projecting beyond one end of the sealant member and terminating in grabbing prongs.

11. Apparatus as set forth in claim 10 wherein a retrieving tool is engageable with said prongs for removing said sealant member from the casing of the well.

12. Apparatus for temporarily sealing the apertures formed in the casing of a well comprising a transporter tube, an adapter member connected to said transporter tube, a weighted stem member connected to said adapter for limited reciprocatory movement with respect thereto, an elongated tubular sealant member formed of a resilient material and having a normal external diameter greater than the internal diameter of said tube, a portion of said sealant member being crimped inwardly throughout its length towards its diametrically disposed portion, a plurality of binding strings affixed to said crimped sealant member to facilitate its insertion into said transporter tube, an anchor member connected to said adapter and sealant member for retaining said sealant member in said transporter tube, a spring cage connected to said sealant member projecting below said transporter tube, means connected to said stem member for lowering said stem member and transporter tube within said casing and positioning said spring cage in engagement with the casing below the area of the apertures, means carried by said adapter and engageable by said stem member for releasing said anchor member to permit the raising of said stem and tube within said casing to withdraw said sealant member from said tube in the area of said apertures and knife means carried by said tube for severing said binding strings and allow said sealant member to expand into engagement with said casing.

13. Apparatus as set forth in claim 12 wherein said adapter has a piston and piston rod secured thereto and said stem member has a plug member slidably mounted on said piston rod with a knife carried by said adapter and engageable by said plug to sever the anchor member secured to said piston rod.

14. The method of sealing perforations and slits in the casing of a well, with a unitary elongated hollow sealant member having a normal external diameter commensurate with the internal diameter of the casing, which comprises longitudinally crimping said sealant member from one end to the other to form an inturbed buckled portion and reduce its external diameter, completely encircling said sealant member at spaced points throughout its length with a plurality of retaining means for securing said sealant member in said crimped condition, lowering said sealant member within said casing to a point adjacent said perforations, removing said retaining means to allow said sealant member to expand into engagement with said casing and overlie the perforations therein.

15. A method in accordance with claim 14 wherein said sealant member is an elongated tubular member and formed of resilient material.

16. A method in accordance with claim 14 wherein said sealant member is an elongated flexible tubular member formed with flexible reinforcing elements.

17. A method in accordance with claim 14 wherein said sealant member is provided with means to effect its removal from the casing.

18. A method in accordance with claim 16 wherein said sealant member is provided with a lubricant coating on its external surface to facilitate its removal from the casing.

19. The method of sealing perforations and slits in the casing of a well with an elongated tubular sealant member having a normal external diameter commensurate with the internal diameter of the casing, which comprises folding and compressing a longitudinally extending portion of said sealant member into close proximity to a diametrically disposed portion of the sealant member, completely encircling said sealant member at spaced points throughout its length with a plurality of retaining means for securing said sealant member in said compressed condition, placing said sealant member in a tubular member and lowering same to a point adjacent said perforations, ejecting the sealant member from said tubular member while removing the securing means therefrom to allow said sealant member to expand into engagement with said casing and overlie and seal said perforations and slits.

20. A unitary sealant member for a well casing comprising an elongated resilient tubular member having a portion thereof compressed throughout its length to reduce its normal overall diameter, one end of said tubular member having a plurality of grab elements mounted therein in spaced relation to one another, said elements projecting axially of and beyond the end of said tubular member to facilitate the moving of said tubular member with respect to said casing.

21. In an apparatus for temporarily sealing apertures formed in the casing of a well, an elongated resilient tubular member of substantially uniform diameter throughout its length, a plurality of wire-like reinforcing elements secured to said tubular member and extending axially thereof and protruding beyond an end of said tubular member, said elements being circumferentially spaced from one another about said tubular member with the protruding portion of the elements being bent to define hook members.

22. In an apparatus as set forth in claim 21 wherein said reinforcing elements extend throughout the axial length of said tubular member.

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