Nov. 26, 1968 C. C. BROWN 3,412,790

WELL PACKER AND METHOD OF MANIPULATING SAME IN A WELL BORE

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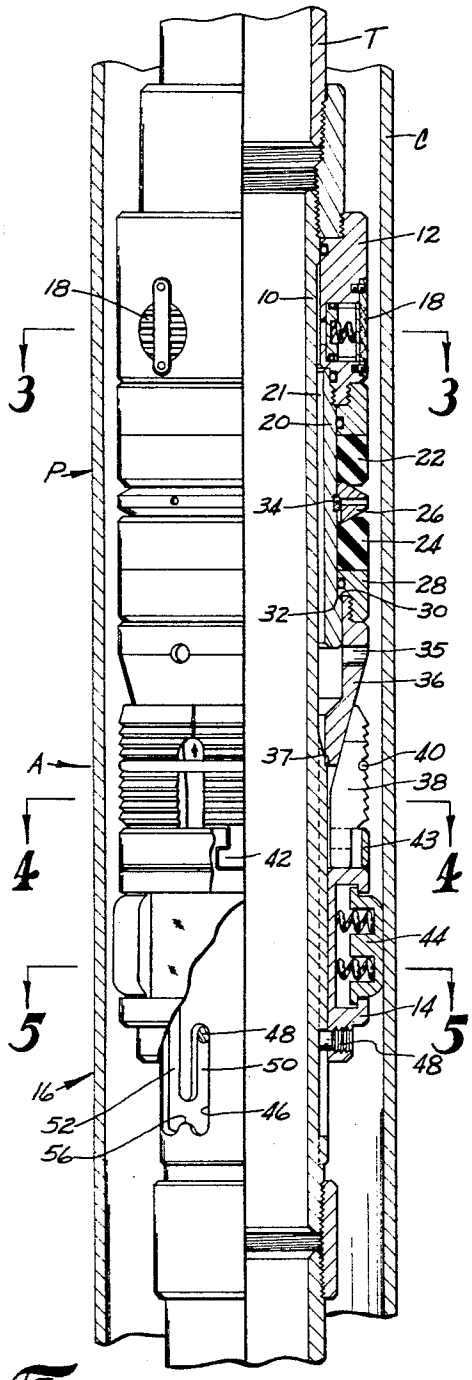


Fig. 1

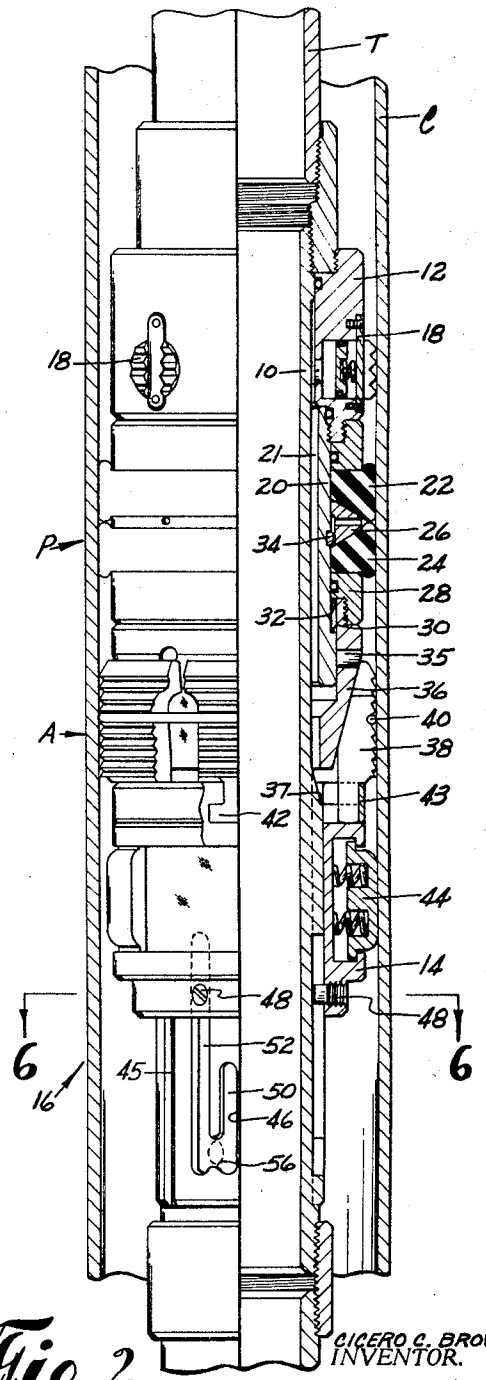


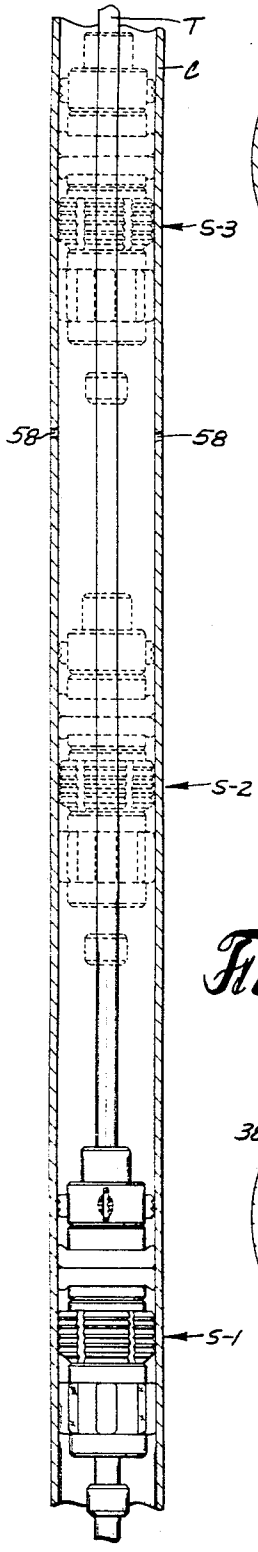
Fig. 2

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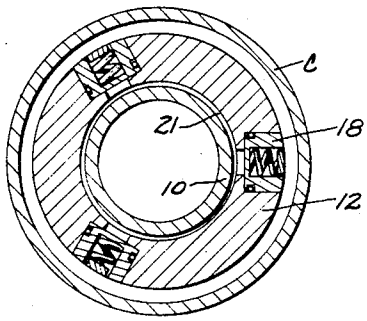


Fig. 3

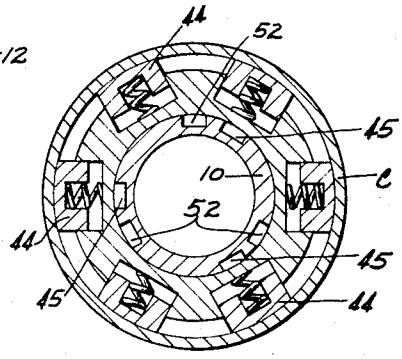


Fig. 5

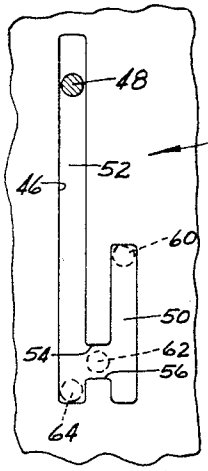


Fig. 7

Fig. 8

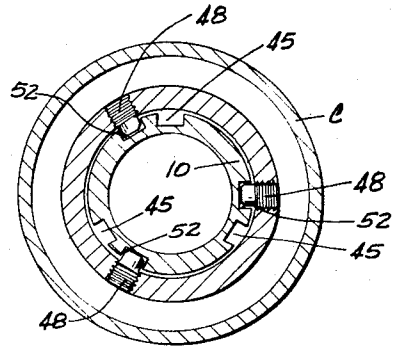


Fig. 6

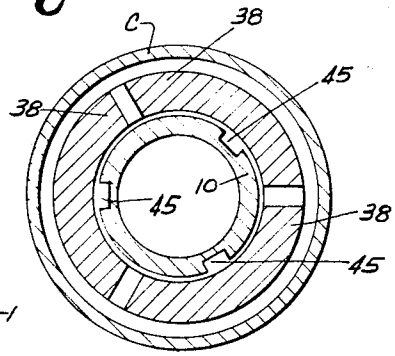


Fig. 4

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WELL PACKER AND METHOD OF MANIPULATING SAME IN A WELL BORE

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ABSTRACT OF THE DISCLOSURE

A well packer and method of using same in a well casing to detect casing leaks, which method includes the steps of lowering the well packer into the casing on a tubing string, rendering the well packer active, setting and releasing the well packer at different levels in the well casing responsive to longitudinal movement of the tubing string and pressure testing the casing for leakage with the well packer set at each level, and which well packer includes an operative connection with an active position and an inactive position together with means for preventing inadvertent movement between said active and inactive positions. This abstract is neither intended to define the invention of the application, which, of course, is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

The present invention relates to a method of manipulating a well packer on a tubing string within a well casing and to a particular construction of the well packer.

In the detection of leaks or perforations in a casing within a well bore, it is a common practice to run a well packer in a tubing string into the casing and set the packer at different levels in order to locate the perforations by pressuring the casing above the packer and noticing whether or not there is a drop in casing pressure. Other procedures in the art of well completion and production require that a packer be run into the well and set and unset at different levels. Operations in the past have required a multiplicity of manipulation in order to set and release a well packer at many different levels in a well bore.

It is, therefore, an important object of this invention to provide an improved method of manipulating a packer on a tubing string within a well casing to set and release the packer at a plurality of positions in the well bore solely by lifting and lowering the tubing string.

Another object of the present invention is to provide an improved method of manipulating a tubing string and a packer supported thereon to locate leaks in a well casing.

A further object is to provide an improved well packer which, after running into a well bore, may be set and unset solely by longitudinal movements of the tubing string to which the packer is attached.

A still further object is to provide a weight-set packer which may be run into a well bore on a tubing string in one position and shifted to a second position by rotation of the tubing string and thereafter set and released to progressively higher positions in the well bore solely by longitudinal movement of the tubing string.

The construction designed to carry out the invention will be hereinafter described, together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

FIGURE 1 is a partial sectional view of the invention with the various parts of the assembly being shown in the running position while the assembly is being lowered within the well bore;

FIGURE 2 is a similar view illustrating the well packer assembly in its set position;

FIGURE 3 is a transverse sectional view taken along line 3—3 in FIGURE 1 through the hold-down buttons in the upper abutement;

FIGURE 4 is a similar view taken along line 4—4 in FIGURE 1 illustrating the gripping slips of the well packer assembly;

FIGURE 5 is another similar view taken along line 5—5 in FIGURE 1 showing the friction drag members of the lower abutment;

FIGURE 6 is a transverse sectional view of the assembly taken along line 6—6 in FIGURE 2 illustrating the connecting means between the packer and its support;

FIGURE 7 is a diagrammatic flat lay-out view of the connecting means between the tubular support and the lower abutment; and

FIGURE 8 is a schematic illustration of a well casing illustrating the packer of the present invention positioned in set position at three different locations within the well casing to illustrate the method of the present invention.

The well packer, as illustrated in the drawings, is mounted on the tubular support or mandrel **10** which is suitably secured to the tubing string T for lowering the well packer into a well casing C. The well packer includes the upper abutment **12** which is secured to the upper end of the tubular support **10** and the lower abutment **14** which is connected to the tubular support **10** by a connecting means **16** with the packing assembly P and the anchoring assembly A positioned in surrounding relation to the tubular support **10** between said abutments. The upper abutment is provided with hydraulically actuated means in the form of the usual hold-down buttons **18**.

The packing assembly P is positioned in surrounding relationship to the tubular support **10** and is secured to the upper abutment **12**. In the packing assembly P, the sleeve **20** threadedly engages the lower interior of the upper abutment **12**. The packing elements **22** and **24**, the central packing cone **26** and the packing follower **28** are mounted on sleeve **20**. The upwardly facing shoulder **30** on the exterior of the sleeve **20** engages the downwardly facing shoulder **32** on the packing follower **28** to limit the downward movement of the packing follower **28** and the lower packing element **24**. The snap ring **34** is positioned in a groove on the exterior of the sleeve **20** to limit the downward movement of the packing cone **26** and the upper packing element **22**. The inner surface of sleeve **20** is spaced from the outer surface of tubular support **10** to provide a passageway **21** communicating with the underside of hold-down buttons **18**.

The anchoring assembly A is also positioned in surrounding relation to the tubular support immediately below the packing assembly P. The anchoring assembly includes the expander **36** and the gripping slips **38**. The expander **36** is threadedly secured to the packing follower **28**. The gripping slips **38** are held in position by suitable means **40**, such as a spring, extending around the well packer and engaging the outer portion of each of the gripping slips **38**. Port **35** extends through expander **36** to communicate with the passageway **21** when in running position. The teeth on the gripping slips **38** are inclined downwardly and will, therefore, when in pipe-gripping position, hold against downward movement while offering only a slight resistance to upward movement. The gripping slips **38** are connected by the usual T connections **42** to the upper end of the lower abutment **14**. These T connections **42** are surounded by the ring **43** which is secured to lower abutment **14**. The ring **42** limits the radial outward movement of the lower ends of the gripping slips **38**. Lower abutment is provided with the usual

spring-loaded friction members **44** which are held in engagement with the interior of casing C at all times.

The lower portion of the tubular support **10** is enlarged in diameter to provide sufficient wall thickness for the connecting means **16**. Also, the upper end portion of such enlargement has the upwardly facing shoulder **37** which in running position engages the lower end of expanders **36**. Additionally, a plurality of longitudinal grooves **45** is provided in the exterior of this enlarged lower portion of tubular support **10** to communicate from below the lower abutment **14** to the passageway **21**.

The connecting means **16** between the tubular support **10** and the lower abutment **14** is formed by a plurality of special grooves **46** in a thick lower portion of tubular support **10** in which the inner end of pins **48**, which are secured to lower abutment **14**, are positioned. As shown best in FIGURE 7, each of the grooves **46** is composed of a short vertical grove leg **50** and a substantially elongated vertical groove leg **52**, which legs are interconnected by a transverse or circumferential groove **54** at a point slightly above the lower ends of such legs. Thus, the projections **56** between the lower ends of legs **50** and **52** provide a means of preventing the inadvertent movement of the pins **48** from one leg to the other of the special grooves **46**.

In operation, as shown in FIGURE 1, the well packer is lowered into the well casing C with the pin **48** positioned in the upper end of the leg **50** of the groove **46**, such position being designated **60** in FIGURE 7. This position of the pin **48** in the short leg **50** holds lower abutment **14** in inactive position to allow the well packer to be either lowered or raised within the casing C without setting the packing assembly P or the anchoring assembly A. Because of the friction members **44**, the pins **48** remain in the upper end of legs **50** in an inactive position while the well packer is being run. Thereafter, when it is desired to position the connecting means **16** in the active position to allow setting of the well packer, the tubing string T is raised to position the pins **48** in the lower end of the legs **50**. Thereafter, the tubing string is rotated counterclockwise and lowered very slightly to allow the pins to pass through the transverse grooves **54** and avoid the projections **56**. The tubing string may be rotated while lifting to avoid the slight lowering if it is desired to further limit the movements of the tubing string. In such case, the pins **48** will pass through the grooves **54** before they reach the lower end of legs **50**. The position of pins **48** in grooves **54** is shown in FIGURE 7 in dashed lines and is designated **62**.

Thereafter, if it is desired that the well packer be set, the tubing string T is lowered and the parts assume the position illustrated in FIGURE 2. Because the legs **52** are longer and the friction members **44** prevent the lower abutment from moving downwardly with the downward movement of the tubular support **10**, the downward movement of the upper abutment compresses the packing assembly P, expanding the packing elements **22** and **24** radially outwardly into sealing engagement with the wall of the casing C, and also forces the expander **36** under the gripping slips **38** to move the slips **38** outwardly into pipe-gripping position with the wall of the casing C. This completes the setting of the well packer. In this set position the pins **48** are positioned in legs **52** as indicated in solid section in FIGURE 7. Legs **52** must be sufficiently long so that in set position the pins **48** do not engage the upper end of legs **52**.

To release the well packer from set position, it is only necessary to lift the tubing string T. Lifting of the tubing string T lifts the upper abutment **12** unsetting the packer assembly P and, when shoulder **30** on the sleeve **20** engages the shoulder **32** on the follower **28** and the lower end of expander **36** engages shoulder **37**, the upward movement lifts the expander **36** out from under the gripping slips **38** allowing the spring means **40** to retract the gripping slips **38** out of engagement with the well casing C. The pins **48** at the completion of the upward release movement of the tubular support **10** will be positioned within the lower end of legs **52**, such position being designated **64** in FIGURE 7. The projections **56** will prevent the pins from moving through the transverse grooves **54** into the legs **50**. The well packer may then be raised by simply raising the tubing string to a level at which it is desired to set the packer and, thereafter, the lowering of the tubing string repeats the setting of the well packer as previously described.

In the event it is desired to lower the well packer after it has once been set, it is necessary that the connecting means **16** be returned to inactive position by rotating the tubing string T and the tubular support **10** in a clockwise direction after the well packer has been completely unset and, while rotating, slightly lowering the tubing string to allow the pins **48** to pass through the transverse grooves **54** and avoid the projections **56**. When the pins **48** are in legs **50**, the well packer cannot be set and can be readily moved either upward or downward in the well.

The usual passageways, including grooves **45**, port **35** and passageway **21**, are provided through the expander **36** and behind the sleeve **20** to expose the interior of hold-down buttons **18** to hydraulic pressure from below the packing element to prevent upward movement of the set well packer when exposed to pressures from below. This is necessary because of the downward inclination of the teeth on the gripping slips **38**. Downward movement of the well packer is prevented by the firm engagement of the teeth of gripping slips **38** when set.

The method of manipulating the well packer is best understood by reference to the illustration of FIGURE 8. In FIGURE 8 the well casing C has perforations or leaks **58** at a level in the well bore which is not known. To detect such leaks the well packer, as previously described, is lowered within the well casing C supported on the tubing string T to the lowest position to be checked. Thereafter, it is released by rotation from inactive position and set. When set, the casing annulus may be pressured and any drop in pressure noted, thereby determining that the perforations **58** are above the set position of the well packer. This original set position is designated **S–1** in FIGURE 8. The well packer is released from set position by lifting of the tubing string and, without stopping the lifting motion of the tubing string, the well packer is raised within the casing to the next level, indicated as **S–2**. The packer is set by lowering the tubing string and a pressure test for leaks is performed. At this level the well packer is still below the performations **58**, and this is indicated by the pressure drop when the casing is subjected to pressure. Again, the tubing string is lifted to unset the packer and to lift it to the position designated as **S–3** in FIGURE 8. When the packer is set in the **S–3** position and pressure applied to the casing, the pressure holds since the packer is set at a position above the perforations **58**. This clearly establishes that the perforations **58** are between the last two set positions of the well packer.

Thus, the complete manipulation of the tubing and well packer within the casing C is accomplished by the straight lifting and lowering of the tubing string. This elminates other movements which have been necessary for the setting of prior well packers and assures that the well packer sets and releases each time the tubing string is lowered and lifted until the connecting means **16** is returned to inactive position. Once the packer is within the well, the inactive position of the connecting means is only used when it is desired to lower the well packer within the casing C.

It should be noted that the structure of the well packer as shown in the drawings may readily be converted from a weight-set well packer to a tension-set well packer by connecting the lower end of the packer assembly to the tubing string and lowering the assembly, upper abutment **12** first, into the well bore. With this configuration, the assembly may be lowered on the tubing string in the ac-

tive position to the highest level at which it is to be set. It is set by lifting the tubing string, which action is identical with the normal setting by lowering the tubing string. The well packer assembly is then released or unset by lowering the tubing string. Continued lowering of the tubing string will move the well packer assembly down in the well bore to the next lower position. The well packer assembly is set and lowered at progessively lower positions in the well bore until the setting is complete. Thereafter, to remove the well packer assembly from the well bore, the assembly is released and the tubing string rotated to move the connecting means **16** to the inactive position. With connecting means **16** held inactive, the well packer assembly is readily removed from the well bore.

From the foregoing, it can be seen that the method of manipulating the well packer is greatly simplified over prior methods in that it only requires a straight longitudinal movement of the tubing string either up or down to set, release and change the position of the well packer within the well casing. The weight-set well packer of the present invention provides a novel connecting means by which this manipulation is made possible.

The foregoing disclosure and description of the invention is illustrative and explantory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. The method of locating a leak through a well casing, including the steps of

lowering a weight-set well packer on a tubing string downwardly into the lower part of said well casing with said well packer held in inactive position,

lifting and rotating said tubing string to move said well packer to active position,

lowering the tubing string to set said packer,

pressure testing for leakage,

raising the tubing string to release said packer and lift the packer to a higher position in said well casing, and

repeating the steps of lowering said tubing string to set the packer, pressure testing for leakage and raising the tubing string to release said packer and lift said packer to a higher position in said well casing until the level of leakage through said casing is located.

2. The method of locating a leak through a well casing, including the steps of

lowering a well packer on a tubing string, which packer may be set by longitudinal reciprocation of the tubing string, into the well casing with said packer held in inactive position,

manipulating the tubing string to move said packer to active position,

moving the tubing string longitudinally in one direction to set said packer,

pressure testing for leakage,

moving the tubing string longitudinally in the opposite direction to release said packer and to move said packer to a different level position in said well casing, and

repeating the steps of moving the tubing string to set said packer, pressure testing, and moving the tubing string to release said packer and to move said packer to a different level in said well casing until the level of leakage through the casing is located.

3. A well packer, comprising

a tubular support adapted to be connected on a tubing string,

upper and lower abutments mounted on said tubular support in spaced relation to each other,

a packing assembly surrounding said tubular support in a position between said abutments,

one of said abutments being secured to said tubular support, and

connecting means between the other of said abutments and said tubular support having active and inactive positions, said inactive position of said connecting means allowing limited longitudinal movement of said other abutments with respect to said tubular support to prevent setting of said packing assembly and said active position of said connecting means allowing sufficient longitudinal movement of said other abutment with respect to said tubular support to set said packing assembly,

said connecting means including,

a pin secured to said other abutment, and grooves in said tubular support including a short longitudinal groove and a long longitudinal groove with a transverse groove connecting between said short and long grooves near one end of said short and long grooves,

said pin engaging in said short groove when in said inactive position and in said long groove when in said active position,

said transverse groove connecting with said longitudinal grooves at a short spaced distance from the ends thereof to form a projection preventing inadvertent movement of said pin through said transverse groove.

4. A well packer, comprising

a tubular support adapted to be connected on a tubing string,

upper and lower abutments mounted on said tubular support in spaced relation to each other,

a packing assembly surrounding said tubular support in a position between said abutments,

one of said abutments being secured to said tubular support, and

connecting means between the other of said abutments and said tubular support having active and inactive positions, said inactive position of said connecting means allowing limited longitudinal movement of said other abutment with respect to said tubular support to prevent setting of said packing assembly and said active position of said connecting means allowing sufficient longitudinal movement of said other abutment with respect to said tubular support to set said packing assembly,

said connecting means including,

a pin secured to said other abutment,

grooves in said tubular support including a short longitudinal groove and a long longitudinal groove with a transverse groove connecting between said short and long grooves near one end of said short and long grooves,

said pin engaging in said short groove when in said inactive position and in said long groove when in said active position, and

means in said connecting means to prevent inadvertent movement of said connecting means between said active and inactive positions.

5. A well packer, comprising

a tubular support adapted to be connected on a tubing string,

upper and lower abutments mounted on said tubular support in spaced relation to each other,

a packing assembly surrounding said tubular support in a position between said abutments,

one of said abutments being secured to said tubular support, and

connecting means between the other of said abutments and said tubular support having active and inactive positions, said inactive position of said connecting means allowing limited longitudinal movement of said other abutment with respect to said tubular support to prevent setting of said packing assembly and said active position of said connecting means allowing sufficient longitudinal movement of said other abut-

ment with respect to said tubular support to set said packing assembly,

an anchoring assembly mounted on said tubular support and adapted to be set when said packing assembly is set,

said connecting means including,

a pin secured to said other abutment,

grooves in said tubular support including a short longitudinal groove and a long longitudinal groove with a transverse groove connecting between said short and long grooves near one end of said short and long grooves,

said pin engaging in said short groove when in said inactive position and in said long groove when in said active position, and

means in said connecting means to prevent inadvertent movement of said connecting means between said active and inactive positions.

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