

Nov. 6, 1962

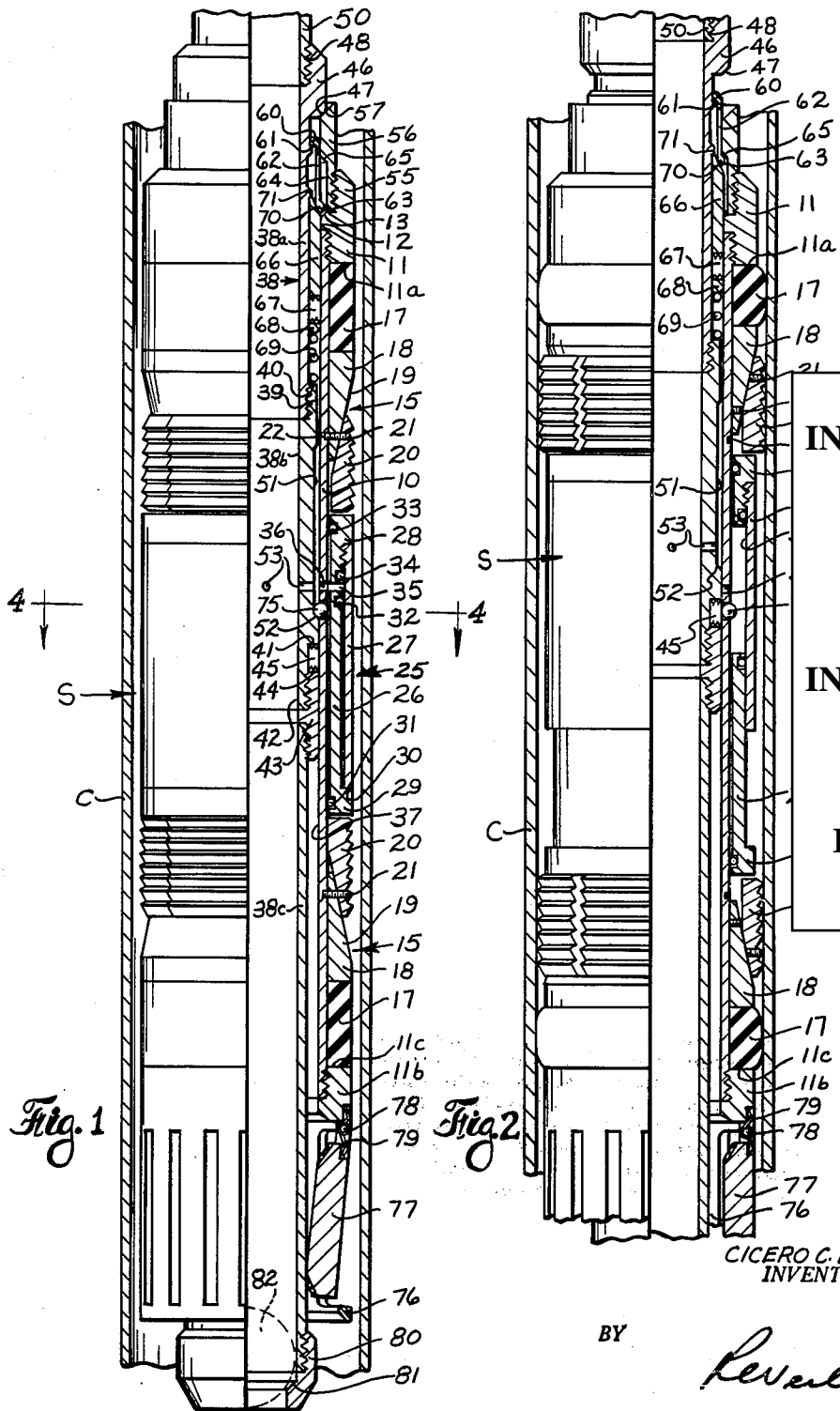
C. C. BROWN

3,062,291

PERMANENT-TYPE WELL PACKER

Filed May 11, 1959

3 Sheets-Sheet 1



**WEATHERFORD
INTERNATIONAL, LLC,
et al.**

EXHIBIT 1016

**WEATHERFORD
INTERNATIONAL, LLC,
et al.**

v.

**PACKERS PLUS
ENERGY SERVICES,
INC.**

CICERO C. BROWN
INVENTOR.

BY *Rever*
ATTORNEY

Nov. 6, 1962

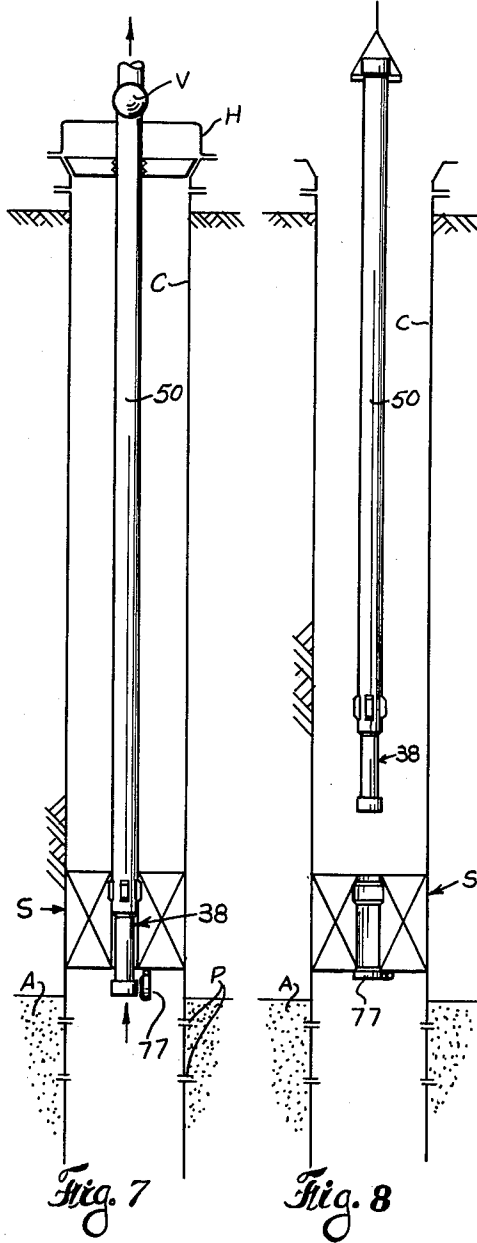
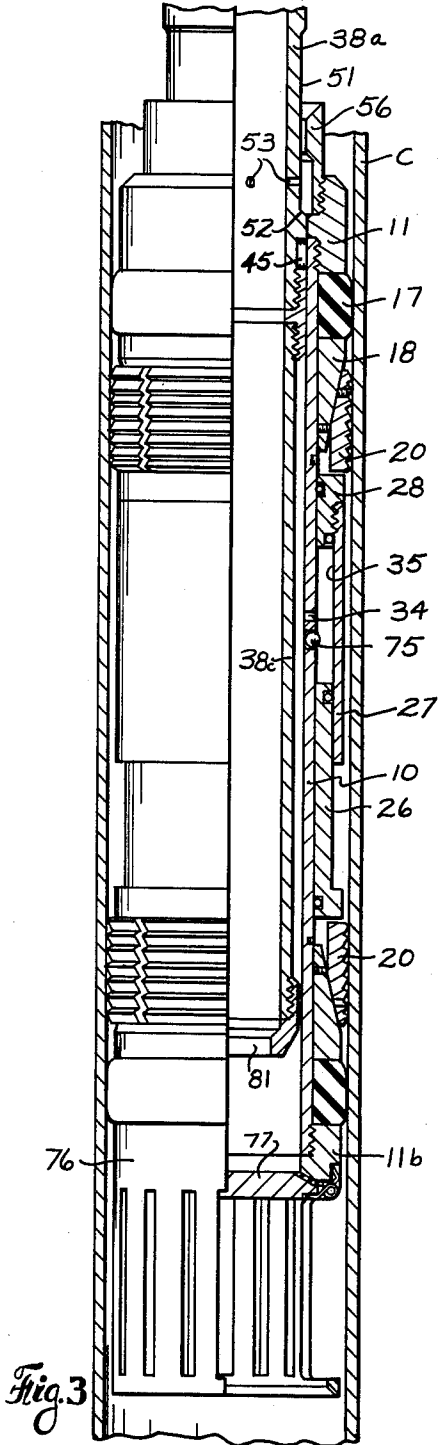
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

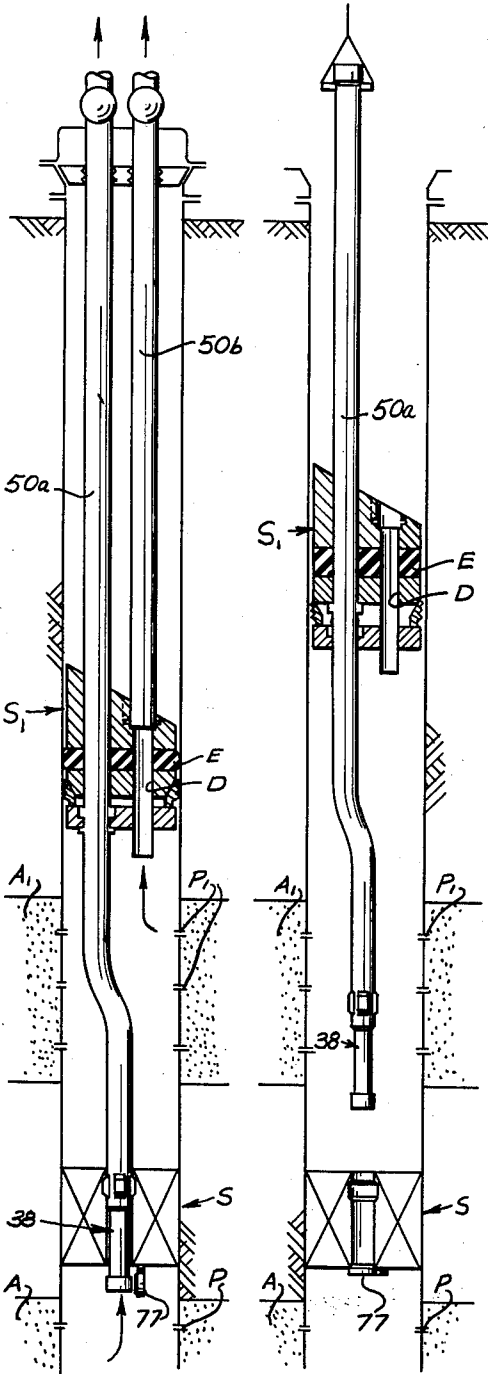


Fig. 9

Fig. 10

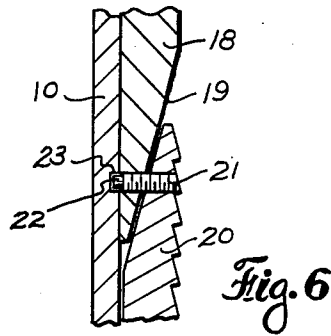


Fig. 6

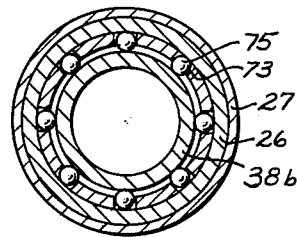


Fig. 4

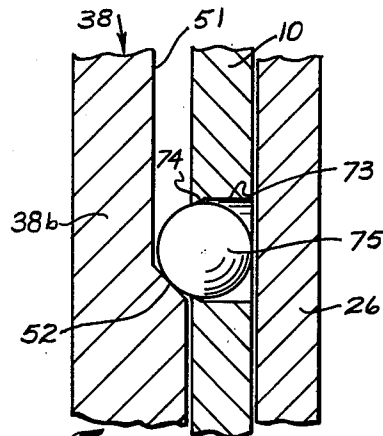


Fig. 5

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3,062,291

PERMANENT-TYPE WELL PACKER

Cicero C. Brown, Houston, Tex., assignor to Brown Oil Tools, Inc., Houston, Tex., a corporation of Texas
 Filed May 11, 1959, Ser. No. 812,263
 9 Claims. (Cl. 166—119)

This invention relates to well packers and particularly to well packers of the so-called "permanent-type" packers. These packers are designed, when once set in the well, to remain permanently, but are ordinarily constructed of materials such that they may be readily destroyed by drilling tools when necessary or desirable to remove them.

More conventional types of packers of the general character described are designed to be run either on wire line setting strings or on tubing strings. In both cases, however, these conventional packers require that the setting strings and setting tools, whether a wire line or tubing string is employed, must be removed from the well before the string of production tubing is run into the well and connected to the packer. These more conventional types of packers, therefore, require a multiplicity of operations before the well is equipped for production, and in these operations, control of the well is not feasible or as complete as is desirable, particularly when high pressures are present in the formations penetrated by the well bore.

The present invention has for its principal object the provision of a permanent-type drillable packer which overcomes the major disadvantages of existing designs, such as are noted above, in that it may be run on the production tubing string itself, and before any circulation operations or manipulation operations to set the packer, may be placed in final position in the Christmas tree and thereby permit the blowout preventers to be removed. This permits maintaining the well under complete control throughout the subsequent operations of preparing the well for production and setting the packer; that is, the mud materials may be circulated out of the well and the face of the sand or other producing formation washed to the point at which it is ready to flow before the packer is even set. No setting tools are required to be removed and the entire setting operation is greatly simplified and conducted under secure well control conditions.

An important object of the present invention is to provide a form of packer of the type described in which the packer is set hydraulically, thereby minimizing the mechanical manipulations which are frequently troublesome in setting packers.

Another important object resides in the employment of a packer structure having oppositely acting anchor and seal assemblies operable to anchor the structure in the well casing against movement in either direction while sealing with the well casing, and employing a hydraulically-actuated piston and cylinder arrangement for setting the anchor and seal elements of the assemblies.

Still another object is the provision of a hydraulically-actuated packer structure of the type described, having a valve member for closure the bore of the packer structure upon withdrawal of the operating stem in order to prevent back-flow of pressure fluid from below the packer when the operating stem is out of the packer.

A more specific object is the provision of two longitudinally spaced releasable latch mechanisms for releasably securing the operating stem in the packer body and which will prevent premature setting of the packer.

Other and more specific objects and advantages of this invention will become more readily apparent from the following description taken in connection with the

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with the accompanying drawing which illustrates a useful embodiment in accordance with this invention.

In the drawing:

FIGS. 1 and 2 are longitudinal, partly sectional, views, showing the packer structure positioned in a well casing and illustrating two stages in the operation of the packer;

FIG. 3 is a view generally similar to FIG. 2, but showing the operating stem withdrawn and the back pressure valve in the closed position;

FIG. 4 is a cross-sectional view along line 4—4 of FIG. 1;

FIGS. 5 and 6 are enlarged fragmentary views illustrating some of the details of the packer structure;

FIGS. 7 and 8 are schematic views illustrating the packer employed with a single string of tubing, FIG. 8 showing the tubing string being withdrawn from the packer; and

FIGS. 9 and 10 are schematic views, generally similar to FIGS. 7 and 8, illustrating the present invention employed in conjunction with an additional packer in multiple well completions.

Referring to the drawing, and more particularly to FIGS. 1 and 2, the packer structure S comprises a generally tubular body 10 having its upper end threadedly received in the bore of an upper collar 11 provided with a lip 12 which extends inwardly over the upper end of body 10 and forms a short flush extension thereof. The upper end of lip 12 is chambered to provide a seat 13, for purposes to be described subsequently. The lower end of body 10 is threadedly received in a lower collar 11b. Collars 11 and 11b define external longitudinally spaced opposed shoulders 11a and 11c, respectively, about the exterior of body 10 against which are seated a pair of longitudinally spaced upper and lower anchor-and-seal assemblies of identical form, each designated generally by the numeral 15.

Each of the assemblies 15 comprises the following successively arranged elements: an annular resilient seal element 17 constructed of rubber or other flexible resilient composition material abutting shoulders 11a and 11c; an expander 18 having one end abutting seal element 17 and having a conical surface 19 tapering inwardly toward body 10; a set of wedge-shape pipe-gripping slips 20 which are secured to the expander in longitudinally retracted position by means of a shear screw 21 which extends through registering openings in the adjacent tip portions of slips 20 and expander 18. The inner faces of slips 20 have outwardly tapering surfaces complementing the taper of surface 19. The inner end of shear screw 21 is reduced in diameter to form the end portion 22 which extends into a recess 23 provided in the exterior of body 10 (FIG. 6).

End portions 22 of the shear screws 21 will be dimensioned to have substantially lesser breaking strength than the bodies of shear screws 21. As an example of the relative strengths which will function satisfactorily for the purposes of this invention, portions 22 may be made to have a breaking strength such that it will shear when the pressure in the hydraulic cylinder, to be described later, attains about 1000 lbs. per square inch, while the larger portions of the shear screws will be made to break when said pressure attains about 3000 lbs. per square inch. These values may, of course, be varied depending on the service conditions obtaining in each instance. By this arrangement, it will be seen that shear screw 21 secures the slips 20 to expander 18 against relative movement therebetween and also simultaneously secures both of these elements to body 10, also against movement relative thereto, the slip expander being thereby initially held in retracted or non-setting position. It will be seen that the upper and lower anchor-and-seal

other, are arranged to act in opposite directions so that actuation of the assemblies will anchor the packer structure against movement in either direction when the structure has been set in a well casing, as will be subsequently described.

Positioned concentrically about the exterior of body 10, between the upper and lower anchor-and-seal assemblies 15, is an actuating assembly, designated generally by the numeral 25, which comprises a tubular cylinder 27 concentrically surrounding a piston 26 and secured at its upper end to an annular head 28 forming a closure for the upper end of the cylinder. Cylinder 27 is longitudinally slidable relative to piston 26. The latter is provided, at its lower end, with an annularly enlarged head 29 defining an upwardly facing annular shoulder 30 forming a limit stop for the lower end of cylinder 27. The lower end of head 29 abuts against the base of lower slips 20, while the upper end of head 28 similarly abuts against the base of upper slips 20. Piston 26 is provided with an internal seal 31 to form a fluid-tight seal between the piston and the exterior of body 10 and is provided, near its upper end, with an external seal 32 to seal between the exterior of the piston and cylinder 27. Head 28 of the cylinder is similarly provided with an internal seal 33 for sealing between body 10 and head 28 and an external seal 34 for sealing between the head 28 and cylinder 27. In the fully telescoped position, illustrated in FIG. 1, a space is provided between piston 26 and head 28 defining a piston chamber 35. One or more radial ports 36 are provided through the wall of body 10 communicating with chamber 35 for admission thereto of pressure fluid, as will be subsequently described.

Body 10 has an axial bore 37 into which extends a tubular operating stem or mandrel, designated generally by the numeral 38. Mandrel 38 comprises co-axially connected upper, intermediate, and lower sections 38a, 38b and 38c, respectively. The external diameters of upper sections 38a is somewhat smaller than that of intermediate section 38b and is threaded at its lower end for threaded reception in an internally threaded socket 39 formed in the upper end of intermediate section 38b. The larger external diameter of the latter defines an annular upwardly facing shoulder 40 about the lower end of the upper section 38a. The lower end of intermediate section 38b is reduced in diameter to define the downwardly facing shoulder 41 about the lower end of intermediate section 38b and the reduced lower end portion of the latter is externally threaded to form the pin connection 42 for reception in a coupling collar 43, the lower end of which threadedly receives the upper end of lower mandrel section 38c to complete the connections between the mandrel sections. The upper end of collar 43 forms an upwardly facing shoulder 44 spaced from shoulder 41 and a packing 45 is mounted about pin connection 42 in the space between these shoulders for compression therebetween when the pin connection is screwed into collar 43 whereby to cause packing 45 to form a fluid-tight slidable seal between mandrel 38 and body 10.

At its upper end, upper mandrel section 38a is externally enlarged forming the head 46 and defining the downwardly facing external shoulder 47. Head 46 is provided with the internally threaded socket 48 by which the mandrel 38 may be secured to the lower end of a tubing string 50. The latter (FIG. 7) extends upwardly through a well casing C and a wellhead H at the surface. A valve V controls flow through the tubing string.

The exterior of intermediate mandrel section 38b is reduced somewhat in diameter over a portion of its length to form the annular chamber 51 between intermediate section 38b and the interior wall of body 10. The reduction in diameter of section 38b defines at its lower end the downwardly and outwardly tapering annular shoulder 52. One or more radial ports 53 are provided through the wall of section 38b above shoulder 52 to provide fluid

ber 51. It will be seen from the arrangement of these parts that when mandrel 38 is in the fully telescoped position, illustrated in FIG. 1, chamber 51 will be in communication with ports 36 and thence with piston chamber 35, while the seal formed by packing 45 will be positioned below ports 36 and 53.

Upper collar 11 is counter-bored above the lip 12 to form the internally threaded socket 55 into which is screwed a short tubular extension 56 having at its upper end the inwardly bevelled seat 57 adapted to be engaged by shoulder 47 when mandrel 38 is fully telescoped into body 10. Extension 56 forms part of an upper latch mechanism by which the upper end portion of mandrel 38 may be releasably secured to the packer body and which permits the mandrel to be withdrawn from the body, after the packer is set, by application of a straight upward pull to the mandrel. This latch mechanism is disclosed and described in greater detail in my co-pending application Serial No. 756,522, filed August 28, 1958 for a "Coupling Device."

This latch mechanism comprises a ring 60 which is supported on upper mandrel section 38a on a narrow ledge 61 spaced a slight distance below shoulder 47. Ring 60 has formed integrally therewith a plurality of angularly spaced depending fingers 62 of resilient construction and having pawls or dogs 63 on their lower ends which project radially into a counter-bore 64 in the lower end of extension 56, the upper end of the counter-bore terminates at the downwardly bevelled shoulder 13. Dogs 63 have their upper and lower ends tapered to complement shoulders 65 and 70, respectively.

A keeper sleeve 66 is slidably mounted on mandrel section 38a between the latter and the upper end of body 10, the keeper sleeve being positioned above shoulder 40. A packing 67 is mounted about mandrel section 38a below keeper sleeve 66, and a thrust ring 68 is positioned below packing 67 and urged thereagainst by a coil spring 69 disposed between shoulder 40 and ring 68. Spring 69 not only compresses packing 67, thereby forming a slidable seal between mandrel section 38a and body 10, but also urges keeper sleeve 66 upwardly. The upper end of keeper sleeve 66 has a downwardly and outwardly and bevelled end face 70 adapted to engage a similarly sloping end face on dogs 63, thereby being operable to urge the dogs outwardly into counterbore 64, and to cause the dogs to engage shoulder 65 when the keeper sleeve moves upwardly to the position shown in FIG. 2, in a manner to be subsequently described. A narrow shoulder 71 limits the upward movement of keeper sleeve 66 on mandrel section 38a to prevent keeper sleeve 66 from attaining a point above dogs 63. The operation of the latch mechanism will be described more fully hereinafter.

Body 10 is provided with a plurality of circumferentially spaced radial openings 73 which are constricted slightly at their outer ends at 74 to define sockets for the reception of ball-shaped latches 75 which project outwardly through the constricted end 74 into engagement with shoulder 52 when the mandrel member is fully telescoped in body 10, as illustrated in FIGS. 1 and 5. In its fully retracted position, piston member 26 will extend upwardly past ball latches 75, the clearance between piston 26 and body 10 being such that the outer surface of the piston will hold the balls in engagement with shoulder 52, thereby providing a latching arrangement by which mandrel 38 cannot be drawn upwardly relative to body 10 while the ball latches are engaged with shoulder 52. When piston member 26 has moved downwardly in response to hydraulic pressure, as best seen in FIGS. 2 and 3, ball latches 75 will be released for movement outwardly of openings 73 into chamber 35 and when so released, it will be seen that the mandrel may be drawn upwardly relative to body 10.

Lower collar 11b has a longitudinally slotted tubular extension 76 which is commonly termed a "junk pusher"

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