FULL-OPENING PARALLEL-STRING HOOKUPS

and the Baker Retainer Production Packer

Parallel-string hookups overcome many of the major stumbling blocks previously encountered in dual-zone installations and in so doing approach the "two wells for the price of one" goal more closely than any other previous production system.
This Bulletin describes all current Baker Full-Opening, Parallel-String Hookups and contains additional information, such as Parallel-String Combined Diameter Charts for all probable combinations of tubing sizes and types, that will prove invaluable in planning any parallel-string installation.

BAKER OIL TOOLS, INC.

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Combined Parallel-String Diameters

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Fig. 1
Baker Model "D"
Retainer Production Packer
Product No. 415-D

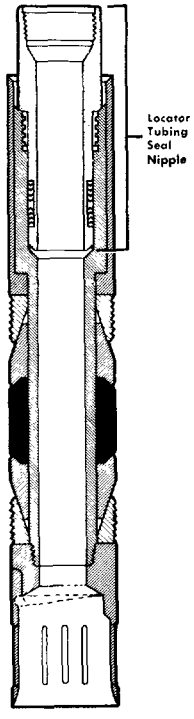


Fig. 2
Baker Model "DA"
Retainer Production Packer
Product No. 415-DA

FULL-OPENING, PARALLEL-STRING HOOKUPS AND THE BAKER RETAINER PRODUCTION PACKER

Introduction

The basic reason for a dual completion is one of greater economy. Though not entirely true, the *"two wells for the price of one"* theory, the resulting decrease in pay-out time and the shortage of casing are the prime reasons that dual completions exist. *Until the successful introduction of parallel-strings—all dual completions produced one zone through the annulus.* This practice, though far from ideal, was necessary in view of the equipment available at the time. All further developments, such as Baker Change-Over Flow Tubes and the Baker Selective Dual-Zone Production Hookup, were designed to alleviate this problem — and to make subsequent production and work-over costs low enough to realize the true advantage of a dual completion: two wells for the completion cost of one.

Parallel-string hookups overcome many of the major stumbling blocks previously encountered in dual-zone installations and in so doing approach the "two wells for the price of one" goal more closely than any other previous production system. As more experience is gained, and successful artificial lift systems developed, parallel-string dual-zone production installations will spread even into areas previously believed to be totally unsuited for dual-zone exploitation.

This Bulletin describes all current Baker Full-Opening, Parallel-String Hookups and includes information on accessories and operational methods that will be of great assistance in planning such hookups.

ADVANTAGES & DISADVANTAGES OF PARALLEL-STRINGS

Advantages:

(1) Permits each zone to be produced through an individual tubing string so that each zone will flow throughout a longer portion of producing life.

(2) Keeps production from the two zones isolated from each other and the casing. This is most desirable from a corrosion and bursting standpoint.

(3) Makes it possible to gas lift or pump either or both zones.

Not all of the Parallel-String Hookups to be described in this Bulletin incorporate all of these advantages. This will be brought out in the discussion of each of the individual hookups.

FEATURES COMMON TO MOST PARALLEL-STRING HOOKUPS

Most operators prefer to run and pull each tubing string independently. This does not mean that either string can be removed independently of the other, but means that one string can be either removed or run at a time provided a certain sequence is followed. Usually the short string (string producing the upper zone) must be removed before the long string (string producing the lower zone) can be removed and vice-versa when running-in. As another general requirement, most operators prefer to have the long string "full-opening" (tubing I.D.) in order to work-over the lower zone using permanent-type well completion methods.

BAKER FULL-OPENING, PARALLEL-STRING HOOKUPS

The hookups described in this Bulletin are designed to be installed as the initial hookup in a flowing well, a gas lift installation, or a pumping installation involving parallel-strings with two sets of rods. Information on parallel-string pumping installations with dual-zone pumps and a single set of rods is available on request, or from a Baker representative who is familiar with such hookups. It should also be pointed out that Parallel-String Hookups are possible in wells in which two Baker Retainer Production Packers have previously been installed, but that these hookups may not have the "full-opening" characteristic. Information on these hookups can be obtained from either the Central or Western Division Baker Sales Offices, provided literature is not available.

BAKER SINGLE-PACKER, FULL-OPENING, PARALLEL-STRING HOOKUPS

Short String Hanging Free

(Refer to Fig. 3)

Description:

This hookup permits production of the lower zone through a full-opening, long string that is packed off from the casing through a Baker Retainer Production Packer. The upper zone is produced through a short string. The short string is not packed off from the casing and hangs free above the Packer.

Applications:

(a) both zones flowing; (b) upper zone flowing, pumping lower zone.

Advantages:

1. *Full-opening (tubing I.D.) long string through Packer to lower zone.* Permits permanent-type well completion work-over methods on lower zone.

2. *Either string can be pulled or run independently of the other.* This is the only hookup that permits either string to be run or pulled independently of the other regardless of sequence. This, of course, is only possible if the couplings and Packer accessories of one string have clearance to pass the couplings and Packer accessories of the other. Certain combinations of tubing sizes permit this and others do not. As a further requirement it may be necessary to run the smaller bore Retainer Production Packers and their accessories. The Locator Tubing Seal Assembly used with the "small bore series" Packers contains a Locator Sub of reduced diameter that will permit the long string to be pulled past the couplings of the short string. Other sizes of Retainer Production Packers can be used but in these instances the long string must be run first and the short string pulled first.

Baker Equipment Required:

1. *Baker Retainer Production Packer, Product No. 415-D.*

2. *Baker Locator or Anchor Tubing Seal Assembly, Product Nos. 442-E2 or 443-E2.* The Locator Tubing Seal Assembly in Sizes 50 and 100 contains a Locator Seal Sub, in place of the Locator Sub, Upper Seal Sub, and Thread Seal that comprise an equivalent section of other sizes of this accessory. The smaller O.D. of the Locator Seal Sub permits the long string to be pulled past the short string.

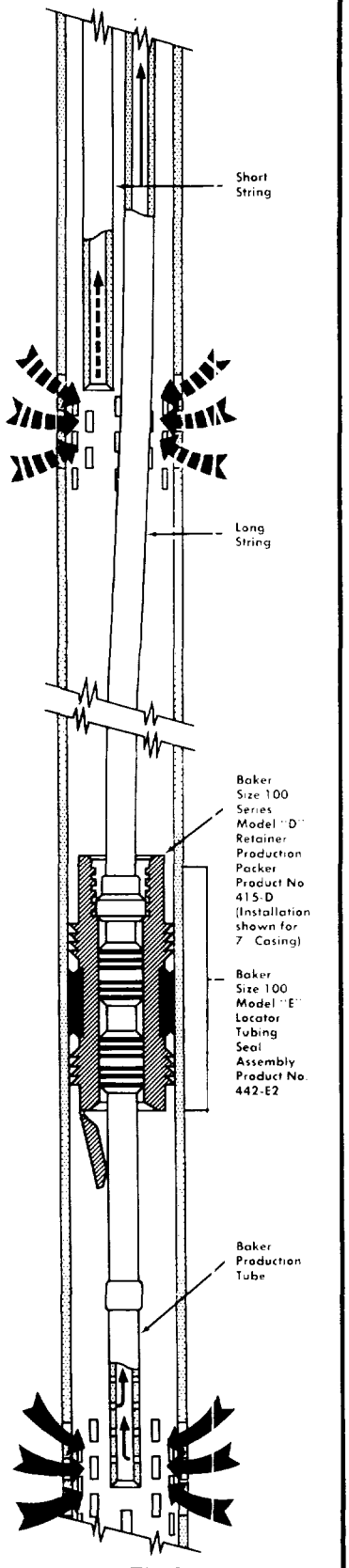


Fig. 3
Baker Single-Packer, Full-Opening Parallel-String Hookup, Short String Hanging Free

3. *Baker Full-Opening Production Tube, Product No. 457-D or 457-E.*

BAKER SINGLE-PACKER, FULL-OPENING, PARALLEL-STRING HOOKUPS

Short String Anchored

(Refer to Fig. 4)

Description:

This hookup permits production of the lower zone through a full-opening long string that is packed off from the casing through a Baker Retainer Production Packer. The upper zone is produced through a short string that is anchored to the long string above the Packer by means of a Parallel-String Anchor with Latching Sub. The short string is not packed off from the casing.

Applications:

(a) flow or pump upper zone; flow or pump lower zone.

Advantages:

1. *Full-opening (tubing I.D.) long string through Packer to lower zone.* Permits permanent-type well completion work-over methods on lower zone.

2. *Either string can be pulled or run separately.* However the long string must always be run first and the short string pulled first.

3. *Short string anchored.* Permits upper zone to be pumped through anchored short string.

Baker Equipment Required:

1. *Baker Model "D" Retainer Production Packer, Product No. 415-D.*

2. *Baker Anchor Tubing Seal Assembly, Product No. 443-E2.*

3. *Baker Full-Opening Production Tube, Product No. 457-D or 457-E.*

4. *Baker Parallel-String Anchor with Latching Sub, Product No. 699 (Refer to Figs. 5 and 6.)* The basic Anchor contains threaded connections for the Upper and Lower Long String Nipples, as well as Left-Hand Threads at its upper portion, into which the Anchor Ring of the Latching Sub "latches" to anchor the short string. Note that the top of the Parallel-String Anchor is machined to a funnel shape with an axis in line with the short string in order to guide the Latching Sub into the Left-Hand Threads. The Upper Long String Nipple with Tubing Thread Box Up and the Lower Long String Nipple with Tubing Thread Pin Down provide connections for the long string. The Short String Nipple with Tubing Thread Box Up provides connection for the short string.

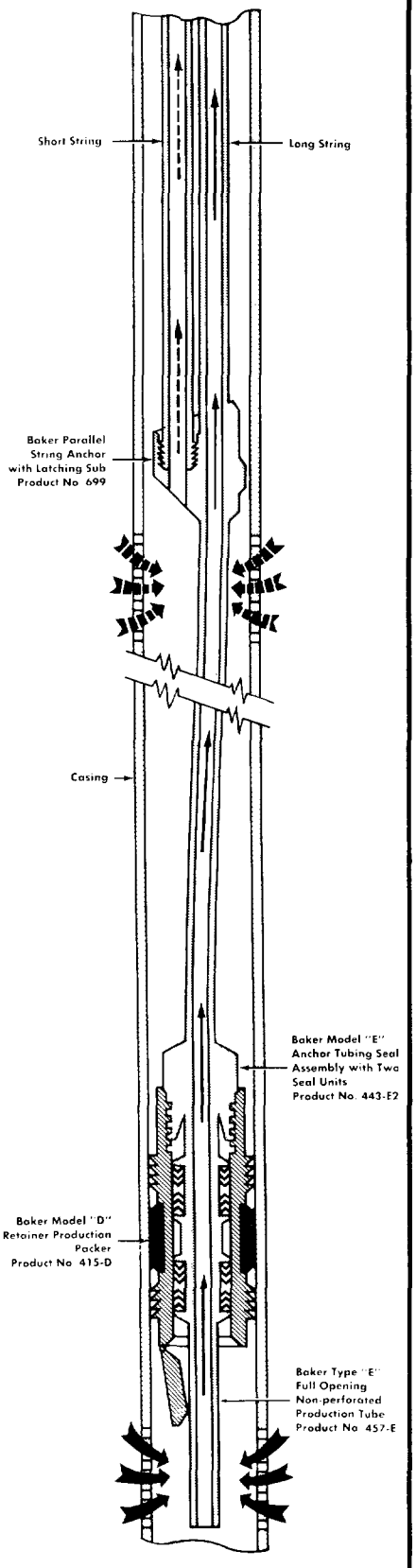


Fig. 4
Baker Single-Packer, Full-Opening Parallel-String Hookup, Short String Anchored

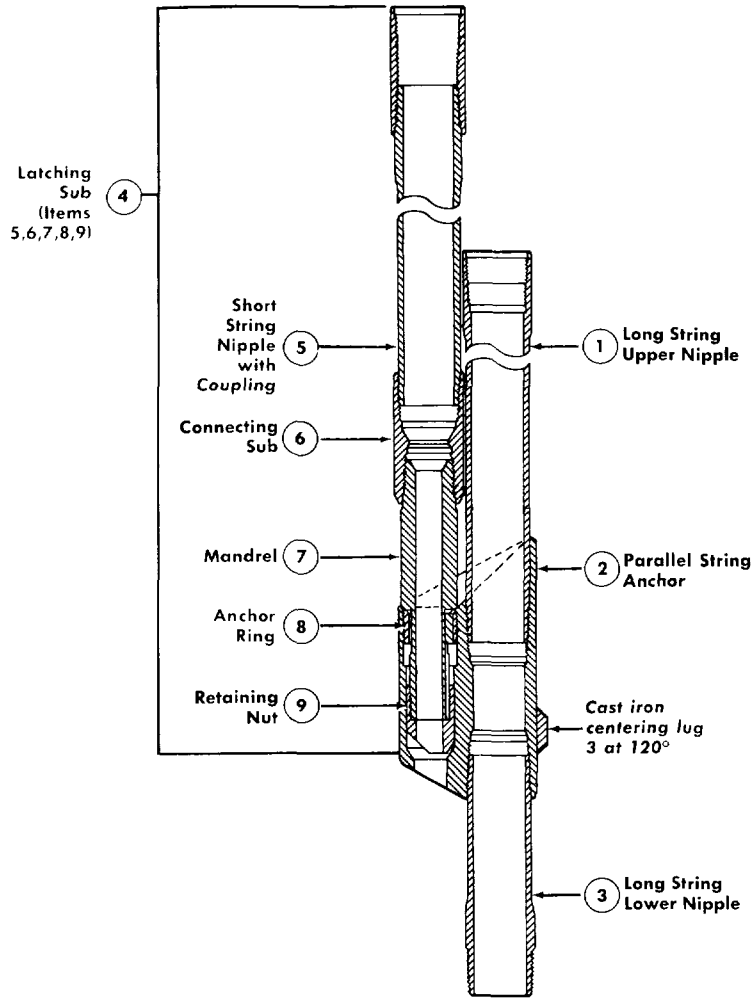


Fig. 5
Baker Parallel String Anchor with Latching Sub Product No. 699

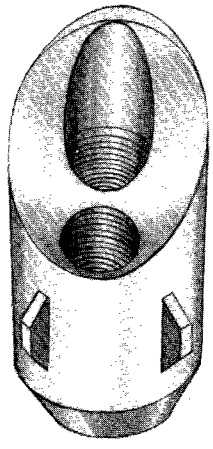


Fig. 6
Exterior view looking at top of Anchor

BAKER TWO-PACKER, FULL-OPENING, PARALLEL-STRING HOOKUP

(Refer to Fig. 7)

Description:

This hookup permits a dual completion with each zone confined to its individual tubing string—with a full-opening long string to the lower zone for the use of all permanent-type, well completion tools. Each string is packed off from the casing annulus. The hookup consists primarily of a Baker Model "DA" Retainer Production Packer (upper Packer), a Baker Model "D" Retainer Production Packer (lower Packer) and a Baker Full-Opening, Parallel Flow Tube (or Baker Full-Opening, Anchor Parallel Flow Tube). This Tube, which is made up into the long string, contains a Seal Nipple at its lower end that seats and seals off in the sealing bore of the Model "DA" Retainer Production Packer. The short string seals off in a sealing bore contained in upper end (Head) of the Flow Tube by means of either a Parallel Locator Seal Nipple, or a Parallel Anchor Seal Nipple. The long string extends down through the lower bore of the Model "DA" Packer to seal off in the bore of a regular Baker Retainer Production Packer through the use of a combination of conventional Baker Tubing Seal Nipples and Spacer Nipples.

Applications:

Two-zone production with (a) both zones flowing, high or low differential pressure; (b) upper zone pumping; lower zone flowing; (c) upper zone flowing; lower zone pumping; (d) both zones pumping.

Advantages:

1. Each zone completely isolated from the other as well as from the casing.
2. Full-opening long string to lower zone.
3. Either string can be pulled or run separately; however, the long string must always be run first and the short string pulled first.
4. Either or both strings can be held in tension if desired, by selecting accessories that incorporate the anchor or latching feature.

Baker Equipment Required:

1. *Baker Model "DA" Retainer Production Packer, Product No. 415-DA (upper Packer).*

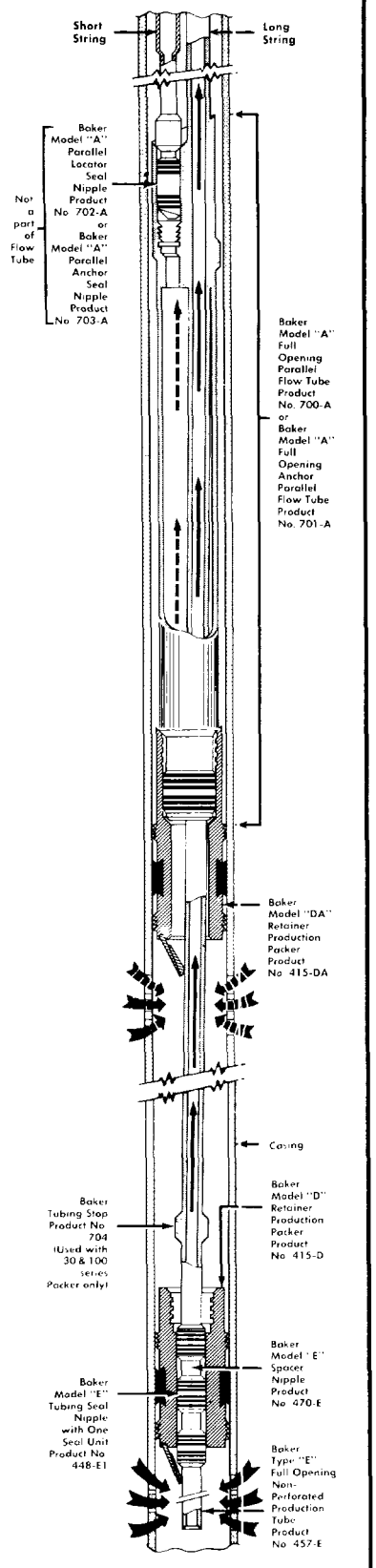


Fig. 7
Baker Two-Packer, Full-Opening Parallel-String Hookup

2. Baker Model "D" Retainer Production Packer, Product No. 415-D (lower Packer). The following combinations of these Packers can be run together:

Size Series DA Packer	can be run with	Size Series D Packer
40-DA		40 or 30*
80-DA		80 or 100*
190-DA		190 or 120*

*Choose size of lower Packer that requires the least set-down weight to retain the Seals in the bore of the Packer. If lower zone is the higher pressure, select the 30, 100 or 210 series (smaller bore) Packers. If the upper zone is the higher pressure, select the 40, 80 or 190 series Packers. The 30 and 100 series Packers might also be recommended because the Tubing Stop, which is used with these sizes of Packers, facilitates the recovery of the tubing below the top Packer should a fishing job be required. *(See Tubing Stop, Fig. 14.)*

3. Baker Model "A" Full Opening, Parallel Flow Tube, Product No. 700-A. (Refer to Figs. 8 and 9.)

The upper portion of this Tube contains a "Head" that is very similar in construction to the Parallel-String Anchor. The Head contains threaded connections for both the Upper and Lower Long String Nipples, as well as a Sealing Bore with Left-Hand Threads. This Sealing Bore in conjunction with the seals contained on either the Parallel Locator or Anchor Seal Nipple, which are made up on the bottom of the short string, provides a means of packing off the short string from the annulus above the upper Packer. Note that the top of the Head is machined to a funnel shape with an axis in line with the short string in order to guide Parallel Seal Nipples into the Sealing Bore. The Head is also available with a threaded connection in place of the sealing bore (Model "B" Full-Opening Parallel Flow Tube, Product No. 700-B) requiring that both strings be run together. A comparatively long extension of flush joint casing, which connects the Head to the Locator-Type Seal Nipple Sub Assembly, is required in order to accommodate the gradual offset necessary to direct the Long String Lower Nipple from its off center location in the Head to its near center position as it emerges into the lower bore of the "DA" Packer. This offset is gradual so that it will not interfere with tools that

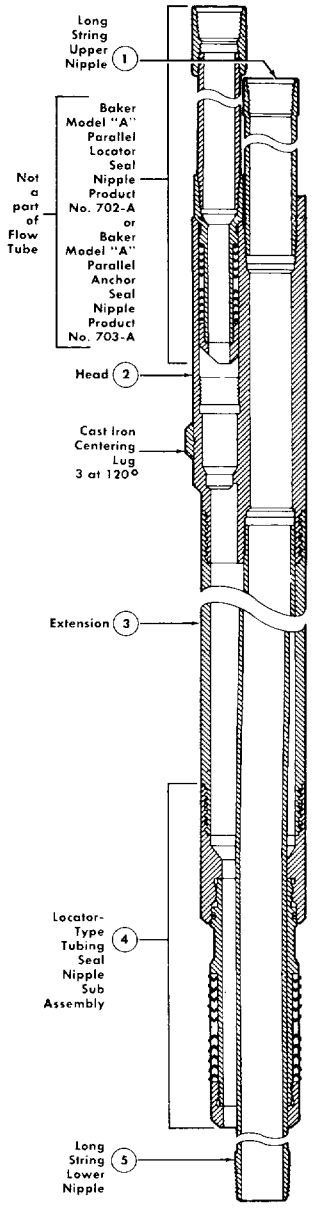


Fig. 8
Baker Model "A" Full-Opening Parallel Flow Tube Product No. 700-A

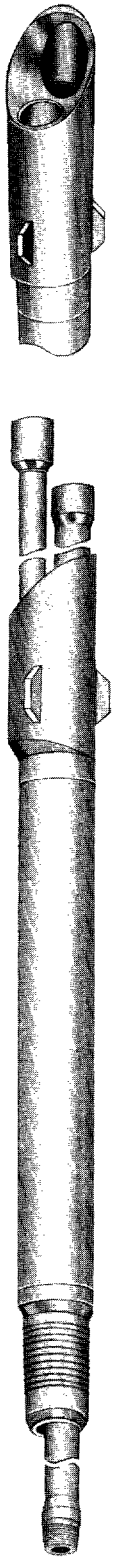


Fig. 9
Illustration of exterior Baker Model "A" Full-Opening, Parallel Flow Tube Product No. 700-A

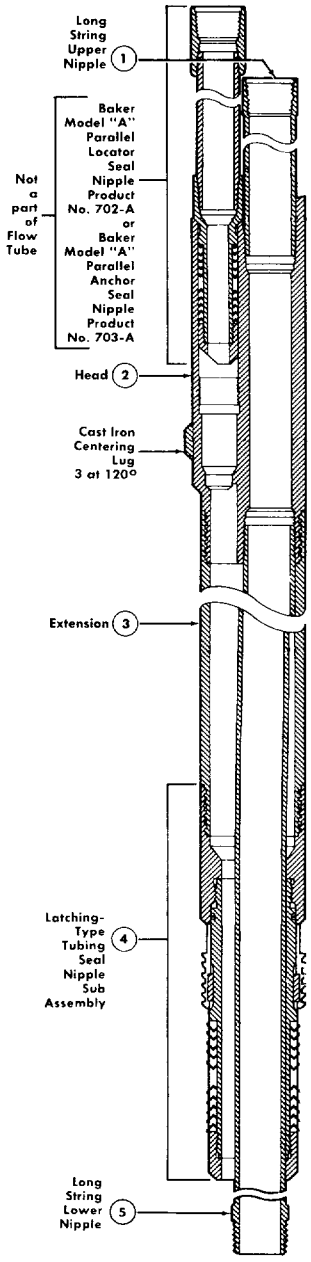


Fig. 10
Baker Model "A" Full-Opening Anchor Parallel Flow Tube Product No. 701-A

may be run through the tubing. This extension varies in length depending upon the size Model "DA" Packer with which it is run. No extension is required for Size 190DA.

4. *Baker Model "A" Full-Opening, Anchor Parallel Flow Tube, Product No. 701-A. (Refer to Fig. 10.)* This product is identical to Product No. 700-A described previously except that it contains a No-Left-Turn Latch for anchoring the long string to the upper Packer. This product is also available with a Head that contains a threaded connection in place of the Sealing Bore (Model "B" Full-Opening, Anchor Parallel Flow Tube, Product No. 701-B) requiring both strings to be run together.

5. *Baker Model "A" Parallel Locator Seal Nipple, Product No. 702-A. (Refer to Fig. 13.)* This product, which is made up on the bottom of the short string, is designed to seal off in the Sealing Bore contained in the Head of either of the Full-Opening Flow Tubes, thus packing off the short string from the casing above the upper Packer. Note that the Bottom Sub of this Nipple contains a bevel on one side to aid in guiding the short string into the Sealing Bore of the Flow Tube Head.

6. *Baker Model "A" Parallel Anchor Seal Nipple, Product No. 703-A. (Refer to Figs. 11 and 12.)* This product is similar to Product 702-A described above except that it contains an Anchor Ring for latching into the Left-Hand Threads located in the Sealing Bore of the Flow Tube Head. Its use makes it possible to anchor the short string if desired.

7. *Baker Tubing Stop, Product No. 704. (Refer to Fig. 14.)* This product is positioned immediately above the top Tubing Seal Nipple for the lower Packer. It does not normally contact the Packer but contains an extension of such a length that if it should contact the Packer, the Top Tubing Seal Nipples will be positioned in the bottom end of the packer bore. Because it contains a Sub of sufficient diameter to seat on the top end of the Retainer Production Packer it serves as a means of holding a Fishing Neck above the "DA" Packer should the tubing or Flow Tube become sanded in. In such cases, the long string can be cut in the Flow Tube just below the Head and the Flow Tube recovered. The Tubing Stop will then prevent the remaining portion of the long string from falling to bottom and provide an extension of the long string above the "DA" Packer that can be used as a fishing neck, to retrieve the remaining portion of the long string. The Tubing Stop is ONLY AVAILABLE IN SIZES 30 AND 100.

8. *Baker Tubing Seal Nipples, Product 448-E1.*

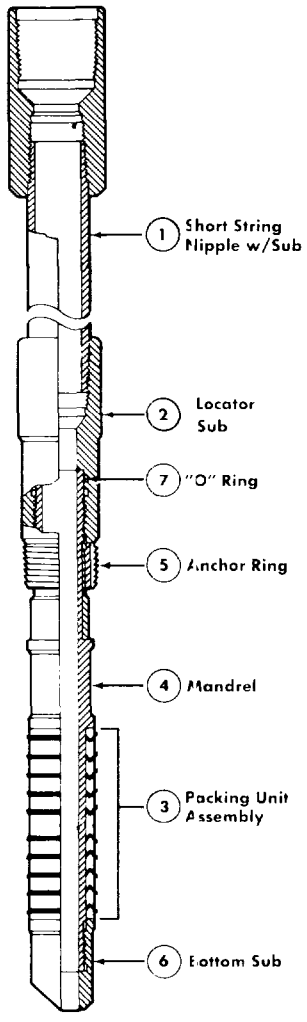


Fig. 11
Baker Model "A" Parallel Anchor Seal Nipple
Product No. 703-A
Size No. 1.68

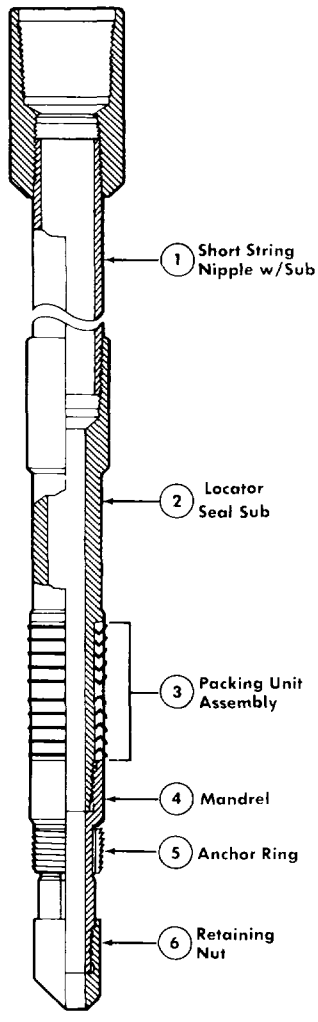


Fig. 12
Baker Model "A" Parallel Anchor Seal Nipple
Product No. 703-A
Size Nos. 1.96 & 2.50

9. *Baker Spacer Nipples, Product No. 470-E.*

10. *Baker Full-Opening, Production Tubes, Product No. 457-D or 457-E.*

Conventional Baker Tubing Seal Nipples and Spacer Nipples are used to provide the necessary seal in the bore of the lower Packer. One of the Baker Full-Opening Production Tubes is run on the bottom of the long string.

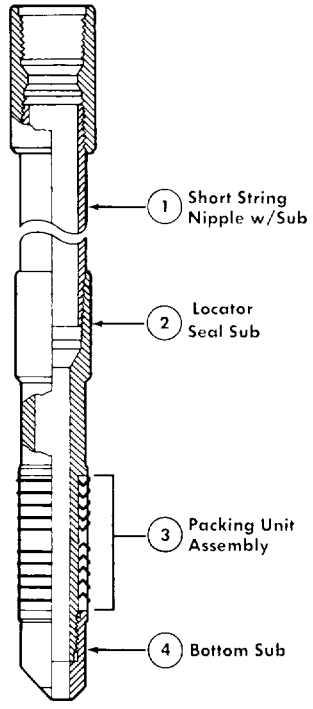


Fig. 13
Baker Model "A" Parallel Locator Seal Nipple Product No. 702-A

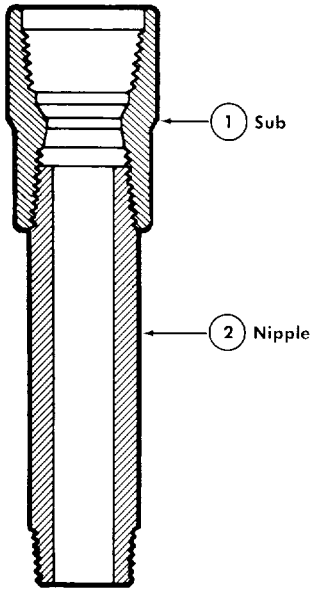


Fig. 14
Baker Tubing Stop Product No. 704

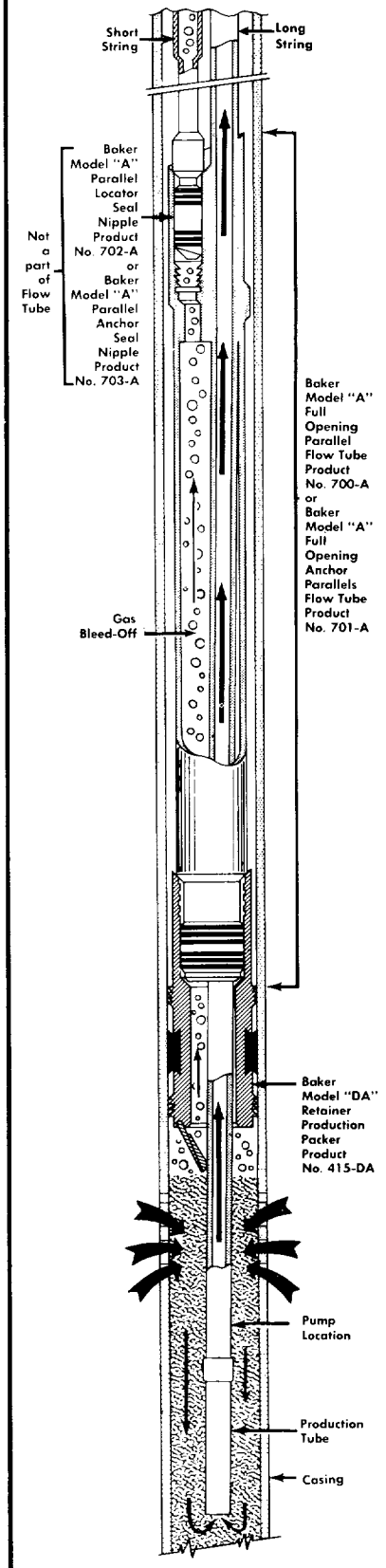


Fig. 15
Baker Single-Packer, Full-Opening Parallel Flow Tube Gas Bleed-Off Pumping Hookup

SINGLE-PACKER GAS BLEED-OFF HOOKUP

This hookup, which is illustrated in Fig. 15, provides a possible means of bleeding gas from a single-packer dual-zone installation in which the lower zone is being pumped. The installation is actually the upper portion of the Two-Packer, Full-Opening Parallel-String Hookup described previously and involves the use of a Baker Model "DA" Retainer Production Packer. This hookup uses the identical Baker Full-Opening, Parallel Flow Tube, Product No. 700-A or the Baker Full-Opening Anchor Parallel Flow Tube, Product 701-A as well as either of the Baker Parallel Seal Nipples, Product No. 702-A or Product No. 703-A which have been described previously.

SET-DOWN WEIGHT REQUIREMENTS FOR BAKER PARALLEL-STRING HOOKUPS

Set-down weight is required on both parallel strings of tubing, in Baker Full-Opening, Parallel-String Hookups involving the Baker Full-Opening, Parallel Flow Tube, Product No. 700-A and Baker Parallel Locator Seal Nipple, Product No. 702-A. If Parallel Locator Seal Nipple is used with Full-Opening, Anchor Parallel Flow Tube, only minimum set-down weight for short string is required. The amount of set-down weight required for a given installation is dependent upon the following factors: (1) the bottom-hole pressures of the two zones, (2) the hydrostatic pressure due to fluid in the well when the tubing strings are run and landed, (3) the hydrostatic pressure due to the fluid in the casing-to-tubing annulus when the well is producing, (4) certain physical dimensions of the components used in the hookup.

To simplify the calculation of set-down weight, a series of simple formulas have been derived for various probable combinations of upper and lower packers and Full-Opening, Parallel Flow Tube sizes. The derivation of the basic equations and their transformation into certain specific set-down weight formulas is shown in Fig. 16. Formulas for other sizes and combinations have not been included because of space limitations. To calculate the set-down weight for a particular size combination of components used, substitute the information obtainable from the well, such as bottom-hole pressure of both zones, hydrostatic pressure of fluid in the annulus when the well is producing.

DERIVATION OF FORMULAS FOR SET-DOWN WEIGHTS USING PARALLEL FLOW TUBE PRODUCT No. 700-A WITH SINGLE-PACKER OR TWO-PACKER HOOKUPS

The total set-down weight required on both strings of tubing in the fluid, which is in the well at the time the tubing is landed, is equal to the set-down weight required based on pressures existing after well completion less the buoyant force acting on both strings when the strings are run in and landed.

Total set-down weight on both strings for a Two-Packer Hookup is expressed in Equation 1:

Eq. 1
$$W_1=[P_1(A\text{-}B\text{-}G)-P_1(E\text{-}G)-P_2(F\text{-}B)+P_2(F\text{-}C)-H_A(A\text{-}B\text{-}D)+H_A(E\text{-}D)]$$
$$-[H_M(A\text{-}B\text{-}G)-H_M(E\text{-}G)-H_M(F\text{-}B)+H_M(F\text{-}C)-H_M(A\text{-}B\text{-}D)+H_M(J\text{-}D)]$$
$$W_1=[P_1(A\text{-}E\text{-}F)+P_2(F\text{-}C)-H_A(A\text{-}B\text{-}J)]-[H_M(B\text{-}C+J\text{-}E)]$$

The minimum set-down weight on the short string for Single-Packer or Two-Packer Hookups is expressed in Equation 2:

Eq. 2
$$W_2=[P_1(D\text{-}G)-P_1(E\text{-}G)+H_A(J\text{-}D)]-[H_M(D\text{-}G)-H_M(E\text{-}G)+H_M(J\text{-}D)]$$
$$W_2=[P_1(D\text{-}E)-H_A(J\text{-}D)]-[H_M(J\text{-}E)]$$

For Single-Packer Hookups $P_1=P_2$. Substituting $P_1=P_2$ in Equation 1 results in Equation 3 expressing total set-down weight for Single-Packer Hookups:

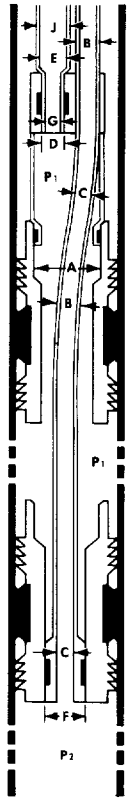
Eq. 3
$$W_3=[P_1(A\text{-}E\text{-}F)+P_1(F\text{-}C)-H_A(A\text{-}B\text{-}J)]-[H_M(B\text{-}C+J\text{-}E)]$$
$$W_3=[P_1(A\text{-}E\text{-}C)-H_A(A\text{-}B\text{-}J)]-[H_M(B\text{-}C+J\text{-}E)]$$

Specific Formulas for a given combination of hookup components can be obtained by substituting the effective areas, as shown below:

Casing Size	Size Tubing Strings		Set-Down Weight Formulas*
	Long	Short	
† 5½"	1.900	1.900	$W_1=1.5P_1+2.8P_2-2.6H_A-1.6H_M+5000SF$
			$W_2=0.2P_1+0.6H_A-0.8H_M+2000SF$
5½"	1.900	1.900	$W_1=0.6P_1+3.6P_2-2.6H_A-1.6H_M+5000SF$
			$W_2=0.2P_1+0.6H_A-0.8H_M+2000SF$
† 7"	2⅜	2⅜	$W_1=3.8P_1+2.5P_2-3.7H_A-2.6H_M+8000SF$
			$W_2=-0.1P_1+1.4H_A-1.3H_M+4000SF$
7"	2⅜	2⅜	$W_1=1.1P_1+5.2P_2-3.7H_A-2.6H_M+8000SF$
			$W_2=-0.1P_1-1.4H_A-1.3H_M+4000SF$
† 9⅝"	2⅞	2⅞	$W_1=15.3P_1+3.6P_2-15.3H_A-3.6H_M+10{,}000SF$
			$W_2=0.2P_1+1.6H_A-1.8H_M+5000SF$
9⅝"	2⅞	2⅞	$W_1=5.9P_1+13.0P_2-15.3H_A-3.6H_M+10{,}000SF$
			$W_2=0.2P_1+1.6H_A-1.8H_M+5000SF$

*Formulas are for set-down weights to be applied when the tubing is landed. Formulas take into account buoyancy of the strings. The last term of each formula represents the safety factor; i.e., 5000 SF, 2000 SF, etc.

†Indicates formulas to be used when smaller bore lower Packer is run.



DEFINITION OF TERMS

W_1=Total set-down weight on both strings Two-Packer Hookup
W_2=Minimum set-down weight on short string with either Two-Packer or Single-Packer Hookups
W_3=Total set-down weight on both strings Single-Packer Hookup
P_1=Bottom-hole pressure of top zone
P_2=Bottom-hole pressure of lower zone
H_A=Hydrostatic pressure of fluid in annulus when well has been completed
H_M=Hydrostatic pressure of fluid in well when tubing strings are run and landed
A=Area of "DA" Packer bore
B=Area of OD of long string
C=Area of ID of long string
D=Area of ID of Flow Tube Receptacle
E=Area of ID of short string
F=Area of "D" Packer bore
G=Area of ID of Seal Nipple
J=Area of OD of short string

Fig. 16

Note that minimum safety factors have been added and are included in each formula. The buoyant effect of the mud in the hole on the tubing strings tends to make the tubing weigh less than it actually will when the well is brought on production. This effect has been taken into account in the formulas, but it makes the set-down weights as calculated from the formulas appear less than might be expected. Actually the weight on the Packer will increase as the well is brought on production. This increase is indicated by the H_m factor. It should be understood that if the Full-Opening, Anchor Parallel Flow Tube, Product No. 701-A is used, there is no need for calculating the set-down weight of both strings. If the short string is not anchored to the Flow Tube, the minimum set-down weight should be calculated for this string.

How to Plan Baker Parallel-String Hookups

The starting point for planning any parallel-string hookup is obviously the determination of the type of available hookup that will best fulfill the desired production requirement. The selection of the type of hookup (single-packer or two-packer) will depend upon the characteristics of the zones to be produced with respect to the most efficient and economical means of recovery (flowing, pumping, gas lift). The next step is the selection from available supply, of the sizes and types of tubing desired for the long and short strings. A chart listing the sizes and specifications of most types of tubing is shown in Fig. 19. Along with the selection of the long and short string tubing, the combined diameter of the long and short string tubing joints with respect to the I.D. of the casing through which the strings are to be run must be considered. The parallel-string diameter charts (Fig. 17 and 18) list the combined joint diameters of various combinations of tubing sizes and types. This combined diameter, when compared with the I.D. of the casing size to be run, will permit the selection of a practical hookup. This information combined with the type of hookup desired (single-packer, two-packer, etc.) along with the production methods to be used (pumping, flowing) is all that is required to order any Baker Parallel-String Hookup. Any qualified Baker Field Engineer can then order exactly the right type and size of the many accessories and Packers available to fit the exacting requirements deemed necessary for any specific installation.

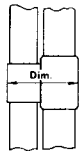
Fig. 17

COMBINED PARALLEL-STRING DIAMETERS, Parallel-Strings Run Separately

TUBING O.D.	1.050 E.U.	1.315 E.U.	1.315 "CS" HYDRIL	1.660 "CS" HYDRIL	1.660 E.U.	1.900 "CS" HYDRIL	1.900 N.U.	1.900 E.U.	2.062 "CS" HYDRIL	2.375 "CS" HYDRIL	2.375 "XL" SPANG	2.375 N.U.	2.375 E.U.	2.875 "CS" HYDRIL	2.875 "XL" SPANG	2.875 N.U.	2.875 E.U.	3.500 "CS" HYDRIL	3.500 "XL" SPANG	3.500 N.U.	3.500 E.U.
1.050 E.U.	3.320																				
1.315 E.U.	3.560	3.800																			
1.315 "CS" HYDRIL	3.212	3.452	3.104																		
1.660 "CS" HYDRIL	3.543	3.783	3.435	3.766																	
1.660 E.U.	3.860	4.100	3.752	4.083	4.400																
1.900 "CS" HYDRIL	3.773	4.013	3.665	3.996	4.313	4.226															
1.900 N.U.	3.860	4.100	3.752	4.083	4.400	4.313	4.400														
1.900 E.U.	4.160	4.400	4.052	4.383	4.700	4.613	4.700	5.000													
2.062 "CS" HYDRIL	3.990	4.230	3.882	4.213	4.530	4.443	4.530	4.830	4.660												
2.375 "CS" HYDRIL	4.362	4.602	4.254	4.585	4.902	4.815	4.902	5.202	5.032	5.404											
2.375 "XL" SPANG	4.660	4.900	4.552	4.883	5.200	5.113	5.200	5.500	5.330	5.702	6.000										
2.375 N.U.	4.535	4.775	4.427	4.758	5.075	4.988	5.075	5.375	5.205	5.577	5.875	5.750									
2.375 E.U.	4.723	4.963	4.615	4.946	5.263	5.176	5.263	5.563	5.393	5.765	6.063	5.938	6.126								
2.875 "CS" HYDRIL	4.880	5.120	4.772	5.103	5.420	5.333	5.420	5.720	5.550	5.922	6.220	6.095	6.283	6.440							
2.875 "XL" SPANG	5.160	5.400	5.052	5.383	5.700	5.613	5.700	6.000	5.830	6.202	6.500	6.375	6.563	6.720	7.000						
2.875 N.U.	5.160	5.400	5.052	5.383	5.700	5.613	5.700	6.000	5.830	6.202	6.500	6.375	6.563	6.720	7.000	7.000					
2.875 E.U.	5.328	5.568	5.220	5.551	5.868	5.781	5.868	6.168	5.998	6.370	6.668	6.543	6.731	6.888	7.168	7.168	7.336				
3.500 "CS" HYDRIL	5.524	5.764	5.416	5.747	6.064	5.977	6.064	6.364	6.194	6.566	6.864	6.739	6.927	7.084	7.364	7.364	7.532	7.728			
3.500 "XL" SPANG	5.910	6.150	5.802	6.133	6.450	6.363	6.450	6.750	6.580	6.952	7.250	7.125	7.313	7.470	7.750	7.750	7.918	8.114	8.500		
3.500 N.U.	5.910	6.150	5.802	6.133	6.450	6.363	6.450	6.750	6.580	6.952	7.250	7.125	7.313	7.470	7.750	7.750	7.918	8.114	8.500	8.500	
3.500 E.U.	6.160	6.400	6.052	6.383	6.700	6.613	6.700	7.000	6.830	7.202	7.500	7.375	7.563	7.720	8.000	8.000	8.168	8.364	8.750	8.750	9.000

The Dimensions listed in this Chart are the exact minimum combined O.D. as shown in the illustration.

CLEARANCE MUST BE ADDED TO THESE DIMENSIONS.



It is recommended that the long string of tubing above the Flow Tube have joints other than couplings. It is possible that the standard couplings would cause damage to the seals on the Parallel Seal Nipple or threads of Latching Sub when the short string is being run into the well. If threaded and coupled tubing is run, it is recommended that all long-string couplings be beveled.

Fig. 18

COMBINED PARALLEL-STRING DIAMETERS, Parallel-Strings Run Simultaneously; Couplings Staggered

TUBING O.D.	1.050 E.U.	1.315 E.U.	1.315 "CS" HYDRIL	1.660 "CS" HYDRIL	1.660 E.U.	1.900 "CS" HYDRIL	1.900 N.U.	1.900 E.U.	2.062 "CS" HYDRIL	2.375 "CS" HYDRIL	2.375 "XL" SPANG	2.375 N.U.	2.375 E.U.	2.875 "CS" HYDRIL	2.875 "XL" SPANG	2.875 N.U.	2.875 E.U.	3.500 "CS" HYDRIL	3.500 "XL" SPANG	3.500 N.U.	3.500 E.U.
1.050 E.U.	3.015																				
1.315 E.U.	3.267	3.508																			
1.315 "CS" HYDRIL	3.093	3.333	2.985																		
1.660 "CS" HYDRIL	3.432	3.672	3.324	3.655																	
1.660 E.U.	3.590	3.830	3.633	3.972	4.130																
1.900 "CS" HYDRIL	3.667	3.907	3.559	3.890	4.207	4.120															
1.900 N.U.	3.710	3.950	3.633	3.972	4.250	4.207	4.250														
1.900 E.U.	3.860	4.108	3.933	4.272	4.430	4.507	4.550	4.700													
2.062 "CS" HYDRIL	3.856	4.096	3.763	4.103	4.396	4.336	4.396	4.696	4.526												
2.375 "CS" HYDRIL	4.199	4.439	4.135	4.474	4.739	4.709	4.752	5.039	4.898	5.241											
2.375 "XL" SPANG	4.355	4.608	4.433	4.772	4.930	5.007	5.050	5.200	5.196	5.539	5.688										
2.375 N.U.	4.285	4.525	4.308	4.647	4.825	4.882	4.925	5.125	5.071	5.414	5.625	5.500									
2.375 E.U.	4.418	4.671	4.496	4.835	4.993	5.070	5.113	5.263	5.259	5.602	5.751	5.688	5.782								
2.875 "CS" HYDRIL	4.708	4.948	4.653	4.992	5.248	5.227	5.270	5.548	5.416	5.759	6.048	5.923	6.111	6.268							
2.875 "XL" SPANG	4.855	5.108	4.933	5.272	5.430	5.507	5.550	5.700	5.696	6.039	6.188	6.125	6.251	6.548	6.688						
2.875 N.U.	4.855	5.108	4.933	5.272	5.430	5.507	5.550	5.700	5.696	6.039	6.188	6.125	6.251	6.548	6.688	6.688					
2.875 E.U.	5.023	5.276	5.101	5.440	5.598	5.675	5.718	5.868	5.864	6.207	6.356	6.293	6.387	6.716	6.856	6.856	6.940				
3.500 "CS" HYDRIL	5.342	5.582	5.297	5.636	5.882	5.871	5.914	6.182	6.060	6.403	6.682	6.557	6.745	6.912	7.182	7.182	7.350	7.546			
3.500 "XL" SPANG	5.605	5.858	5.683	6.022	6.180	6.257	6.300	6.450	6.446	6.789	6.938	6.875	6.969	7.298	7.438	7.438	7.543	7.932	8.125		
3.500 N.U.	5.605	5.858	5.683	6.022	6.180	6.257	6.300	6.450	6.446	6.789	6.938	6.875	6.969	7.298	7.438	7.438	7.543	7.932	8.125	8.125	
3.500 E.U.	5.855	6.108	5.933	6.272	6.430	6.507	6.550	6.700	6.696	7.039	7.188	7.125	7.219	7.548	7.688	7.688	7.772	8.182	8.375	8.375	8.500

The Dimensions listed in this Chart are the exact minimum combined O.D. as shown in the illustration.

CLEARANCE MUST BE ADDED TO THESE DIMENSIONS

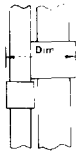


Fig. 19

TUBING DIMENSIONAL DATA

Tubing O.D.	Type Thd.	Tubing Nom.	Wt. Per Ft.	I.D.	Drift Dia.	Inside Dia. Sq. in Area	Joint I.D.	Cplg. O.D. or Joint O.D.	Special Joint O.D.
1.050	E.U.	¾	1.20	.824	.730	.533		1.660	
1.315	E.U.	1	1.80	1.049	.955	.864		1.900	
1.315	Hydril "CS"	1	1.80	1.049	.955	.864	.970	1.552	
1.660	Hydril "CS"	1¼	2.40	1.380	1.286	1.496	1.301	1.883	
1.660	E.U.	1¼	2.40	1.380	1.286	1.496		2.200	
1.900	Hydril "CS"	1½	2.90	1.610	1.516	2.036	1.531	2.113	
1.900	N.U.	1½	2.75	1.610	1.516	2.036		2.200	
1.900	E.U.	1½	2.90	1.610	1.516	2.036		2.500	
2.062*	Hydril "CS"	...	3.4	1.750	1.657	2.405	1.700	2.330	
2.375	Hydril "CS"	2	4.70	1.995	1.901	3.126	1.945	2.702	2.630
2.375	Spang "XL"	2	4.70	1.995	1.901	3.126	**	3.000	
2.375	N.U.	2	4.60	1.995	1.901	3.126		2.875	
2.375	E.U.	2	4.70	1.995	1.901	3.126		3.063	
2.375	E.U.	2	5.95	1.867	1.773	2.737		3.063***	
2.875	Hydril "CS"	2½	6.50	2.441	2.347	4.676	2.370	3.220	3.155
2.875	Spang "XL"	2½	6.50	2.441	2.347	4.676	**	3.500	
2.875	N.U.	2½	6.40	2.441	2.347	4.676		3.500	
2.875	N.U.	2½	8.60	2.259	2.165	4.008		3.500	
2.875	E.U.	2½	6.50	2.441	2.347	4.676		3.668	
2.875	E.U.	2½	8.70	2.259	2.165	4.008		3.668	
3.500	Hydril "CS"	3	9.30	2.992	2.867	7.031	2.921	3.864	3.805
3.500	Spang "XL"	3	9.30	2.992	2.867	7.031	**	4.250	
3.500	N.U.	3	9.20	2.992	2.867	7.031		4.250	
3.500	N.U.	3	12.70	2.750	2.625	5.940		4.250	
3.500	E.U.	3	9.30	2.992	2.867	7.031		4.500	
3.500	E.U.	3	12.95	2.750	2.625	5.940		4.500	
4.000	Hydril "CS"	3½	11.00	3.476	3.351		3.395	4.343	4.315
4.000	N.U.	3½	9.50	3.548	3.423			4.750	
4.000	E.U.	3½	11.00	3.476	3.351			5.000	
4.500	Hydril "CS"	4	12.75	3.958	3.833		3.865	4.855	4.825
4.500	N.U.	4	12.60	3.958	3.833			5.200	
4.500	E.U.	4	12.75	3.958	3.833			5.563	

*Non A.P.I. Tubing. This size is being developed by Hydril.

**Joint I.D. not published but is larger than drfit diameter.

***N-80 Couplings are sometimes turned to 2.910 by the operators. This dia. is listed for reference and does not constitute a recommendation by Baker Oil Tools, Inc.

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