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Workovers on the geothermal wells at Svartsengi

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WORKOVERS ON THE GEOTHERMAL WELLS AT SVARTSENGI:

1. Background.

Precipitation of Calcium carbonate scale is a problem in all wells at Svartsengi. This occures at approximately 400 meters depth. The length of the zone of precipitates is normally between 50 and 100 meters.

The depositions will develope a choke. The flow rate will be reduced as result of the decreased flow area.

Removal of the deposites are necessary every 7th. to 12th. month.

2. Current workover procedure.

The wells are killed by closing the master valve for a certain length of time. The wellhead is removed, and the scale deposites drilled out. The drilling rig is usually a medium sized rig (Failing 3000 or Wabco 2000).

The cuttings are deposited at the bottom of the well.

A certain volume of water is required in order to cool the bit and flush away the cuttings. This water will flow into the production zones.

The wellhead is reinstalled, and the well is brought to flow by means of a compressor.

The whole operation will take approximately one week, in extreeme cases as much as two weeks. The actual cleaning of the well will only take between one or two days.

The delays in bringing the the wells back in operation do not eause any problems with regard to the costumers. The total production from the field is far above the actual demand. This situation will gradually change. It is therefore expected that the workovers must be carried out over a shorter length of time in the future.

Killing of the wells implements a cooling of the wellbore and therefore also the casing string. The temperature under flowing conditions is between 200 and 240 °C, while it will drop down to 10 to 40°C in the sections directly exposed to the cold water. This section is approximately 300 meters long.

Such a temperature drop would have caused a significant reduction of the length of for instance a pipeline of similar length.
The temperature drop will not necessarely cause a reduction in the casing length because the casing is bonded to the formation by the cement, but it will cause increased tensile stresses on the casing string.
There are no reliable method for calculation of these stresses bacause the cement bonding will vary between "perfect" and none existing. In extremely excentric annuli, there will in most cases be no cement in the narrower parts of the annuli, and consequently no cement bonding.

Most cement qualities will shrink when setting. The magnitude of the shrinkage is normally between 1 and 3 %, depending on geometry, cement quality, and placing technique, a somewhat reduced bonding quality must be expected.
It is therefore not possible to design a casing string for such loads because there will be large local variations in the tensile loads introduced by the temperature drop.

A reduction of the local variations of the tensile loads can possibly be achieved by improving the cementing techniques and the cement quality.
Unfortunately has cementing of geothermal wells on Iceland proven to be an extremely difficult task, due to high rates of fluid loss in most wells.

The present procedure for prevention of collapse due to temperature drops is therefore to design the casing string stronger than required from conventional casing string design considerations, hope that it will withstand the loads, and limit the number of temperature drops to an absolute minimum.

This has been the main reason for planing to change the workover procedures at Svartsengi.

3. Proposed new workover procedure.

The workovers are planed performed on flowing wells. Rotating pressure controle equipment is therefore required.

The master valve will be closed while the top of the wellhead and the flowline is removed, and the rotating pressure controle equipment, the BOP, and a new flow line is installed.
In the mean time, the well will be flowed through the kill line (fig. 1).
This is done to avoid the possibility of killing the well while the removals and installations are being made.

This method is rather troublesome because removal and reinstallation of the wellhead and the flowline, and two additional, separate flowline systems, one for the kill line and one for the workover discharge.
The workover operation could be made simpler by installing an additional valve on top of the wellhead (fig. 2). Such a system will not require removal of the the wellhead, and not require two additional flowline systems. The discharge can be produced through the regular flowline system.

The wellheads should be redesigned if such a solution is adopted (fig. 3), but this will not be discussed any further as it is beyond the scope of this memo.

The suggested workover prosedure is therefore:

-shut down the well
-maintain reduced production through the kill line
-remove wellhead top and regular flow line
-install BOP, rotating pressure controle equipment and a flow line
-install the rig
-open master valve and flow the well
-drill out the scale deposites
-close master valve
-open kill line
-remove BOP, rotating pressure controle equipment, and flow line
-remove the rig
-reinstall top of wellhead and flow line
-close kill line
-open master valve

4. Selection of equipment.

3 pieces of equipment is needed:

-a BOP, either a ram type BOP with pipe rams, or a spherical (bag type) BOP
-a rotating drilling head,RDH, a rotating BOP, or similar equipment.
-a diverter for the flow line.

The possibility of using a bag type BOP was investigated, but these were found to be less favourable than ram type BOP-s because the stripping rubber would be vulnerable to high temperatures, and as no high temperature versions of these were available, it was assumed that these were not applicable for high temperature workovers. In addition these BOP-s were found to have about twice the height and weight of the most favourable ram type BOP.

Among the ram type BOP-s there were several possibilities, but there were only one which seemed to be applicable due to the bore requirement of minimum 12,25". The other BOP-s in this size range were designed for pressures far above what we will require 5.000 to 10.000 psi, and were 50 t0 100% heavier.

The selected BOP is a Shaffer, NL Industries, single SL type, with a pressure rating of 3000 psi and a weight of 1360 kilos. Further information on the BOP can be found in appendix I.

There were two rotating drillingheads or rotating BOP-s available, the Grant Tool Co., model 7068, and the Shaffer Type 79.

The type 79 RBOP is a fairly new design based on an older version, the type 50 RBOP. According to information obtained from the manufacturer, the maximum temperature rating for the stripping rubber is 450°F or 232°C.
Drawings and information on the type 79 RBOP are in appendix II.

Grant Tool Co. manufactures a geothermal versions of their stripping rubbers. The temperature rating is approximately 200°C.

The size, price and temperature rating on these two are very similar.
The Grant desing is well known in the industry, while the shaffer design is fairly new. Grant has 85% of the marked for RDH-s. It seems therefore as if the grant RDH is the most favourable piece of equipment.
The model 7068 RDH-s have been used for several years here on Iceland in connection with conventional drilling operations, with satisfactory results.

The RDH can possibly be replaced by a "Pakkdós". The design of this piece of equipment is based on a smaller version used in connection with drilling of smaller wells at relatively low temperatures and pressures, far below those expected at Svartsengi.
A prototype is currently under constuction, but the sealing material for the packer elements and hydraulic system for operation of the equipment has yet to be made available.

Substantial testing will be required before the equipment can be expected to be operational. The equipment, if it is found to function satisfactory, can therefore under no circumstances be expected to be operational before the second half of 81

The Grant RDH is equipped with a diverter, while the "Pakkdós" will require a separate spool for the diverter.

The major problem area in connection with operation of this equipment is expected to be the condition of the stripping rubber when exposed to high temperature steam for some time.

The exposure can probably be reduced by installing a separate diverter spool below the BOP and close the diverter on the RDH.

It is however possible to combine such a spool with an adapter which will be required between the flange on top of the master valve and the flange on the bottom of the BOP.

5. Size of the equipment.

The maximum casing size will be 13 5/8 ". The maximum bit size which can pas through 13 5/8 " casing is 12 1/4 ". The bore size of the wellhead assembly should therefore be larger than 12 1/4 ".
The BOP will therefore be 13 5/8 ", 3000 psi, (ref.: appendix I). The hight of this is in studded version 0,445 meters.

The Grant RDH is available in 12 " and 13 5/8" sizes. For some unknown reason the bore diameter of the 12" version is listed as 14 ". The bore diameter of the 13 5/8 " is 13 5/8".
Both these are therefore applicable.
The 12 " version is somewhat shorter, 0,759 meters vs. 0,810 meters. Both are equipped with short drive bushings.
The pressure rating is higher and the outlet flange is larger on the 13 5/8 ", but these factors are probably of less importance.

The weight is expectedly the same for both versions, and is estimated to 1500 kilos (no information available from manufacturer).

The price is also expected to be the same, US$ 21500.

The 12 " version seems therefore to be the most favourable due to the shorter length, but the 13 5/8 " might be easier to fit on to the BOP.

6. Cost estimate.

There seems to be only to alternative equipment selections :

Alternative 1 : Grant model 7068,12 " RDH, Shaffer single 13 3/8" SL type BOP, with or without a separate diverter spool (fig. 4)

Alternative 2 : "Pakkdós", Shaffer single 13 5/8 " SL BOP with a separatae diverter spoo..

The first alternative will not require any modifications on the rig planed used for this purpose (Wabco 2000)
The only additional equipment nedded will be a 3 1/2" hexagonal kelly, 3 1/2" drill pipe, and 3 1/2" drill collars.

The second alternative will require extensive modifications on the rig. The rig will have to be rebuilt for top drive, a power swivel will be required. The cost of the material and equipment needed has been estimated by the manufacturer of the rig to approximately US$ 62.000. This figure does not include labour costs. The labour costs will expectedly be somwhere between US$ 20.000 and 40.000 US$ 30.000 is therefore used as an estimate.

The prototype is, as mentioned, still under construction. So far has approximately US$ 10.000 been spent on the equipment. How much it will cost to complete the construction and testing is not known. The cost will expectedly be somewhere between US$ 30.000 and 110.000.

In addition will 3 1/2" slik drill pipe and 3 1/2" drill collars be required.

Additional costs for equipment such as flow lines etc. are not included in the cost estimates. The cost estimates for the two alternatives can be seen in table 1 and 2.

6. Recommendations.

1. Test the Grant RDH under realistic operational conditions at Svartsengi
2. Evaluate the results of the testing, and order a Grant RDH if the results were found to be acceptable.
3. If the results were found to be unacceptable, the development of the "pakkdós" should be completed. It is not very likely that the Shaffer RBOP will performe significantly better than the Grant RDH even with a somewhat higher temerature rating on the stripping rubber.
4. Test the "pakkdós" under realistic, operational conditions at Svartsengi.
5. Evaluate the results of the testing, and use the "Pakkdós" if the results of the testing were found to be acceptable.
6. If the results were unacceptable, the Shaffer RBOP should be reevalueted,

but as mentioned, it is very likely that it will performe similarely to the Grant RDH.

Workovers on flowing wells can therefore possibly not be performed if the Grant RDH and the "Pakkdós" are rejected.

Table 1

Cost estimate for altemative 1 (Grant)

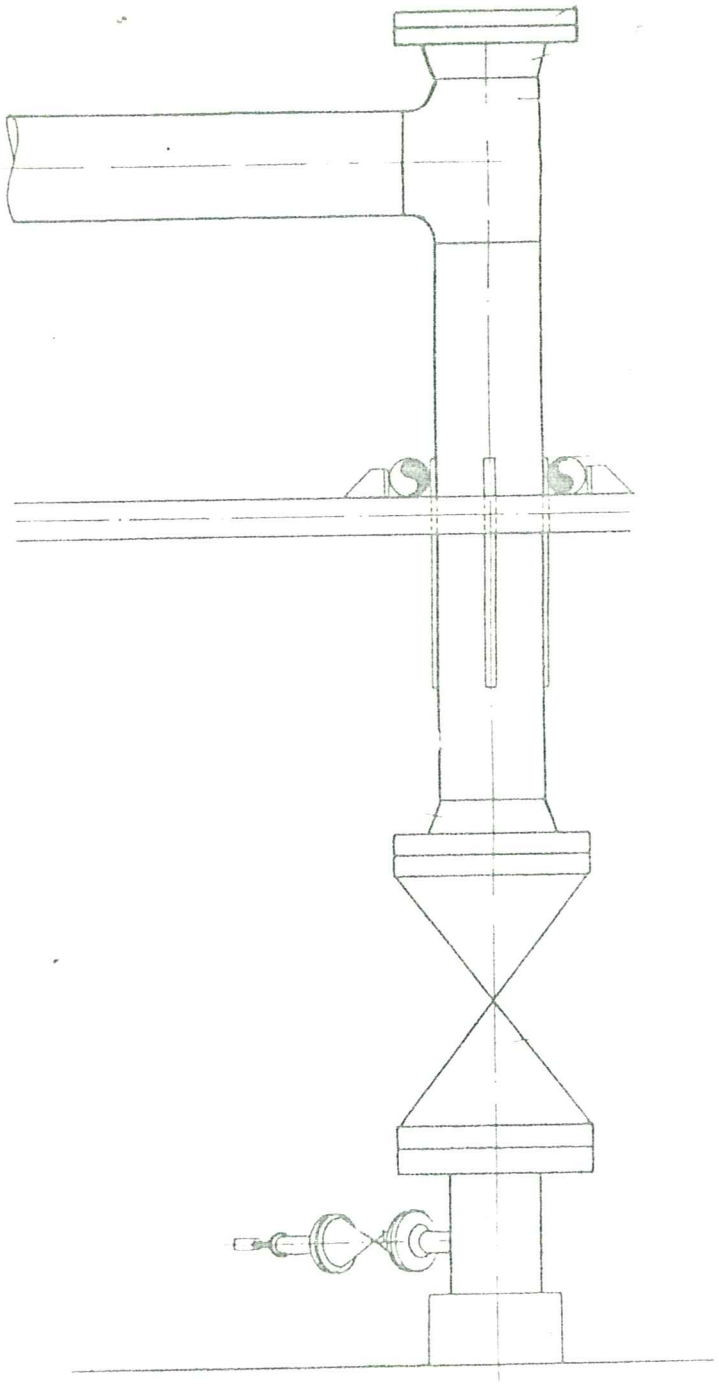
12" Grant RDH; Model 7068, Short version	$	21.500
13 5/8" Shaffer SL BOP	$	74.622
Hexagonal kelly, estimated	$	15.000
600 meters of 3 1/2" IF Drill pipe, estimated	$	35.400
100 meters of 3 1/2" Drill collars, estimated	$	14.150
Spoel/adapter	$	500
		161.172

Table 2

Cost estimate for altemative 2 (Pakkdós)

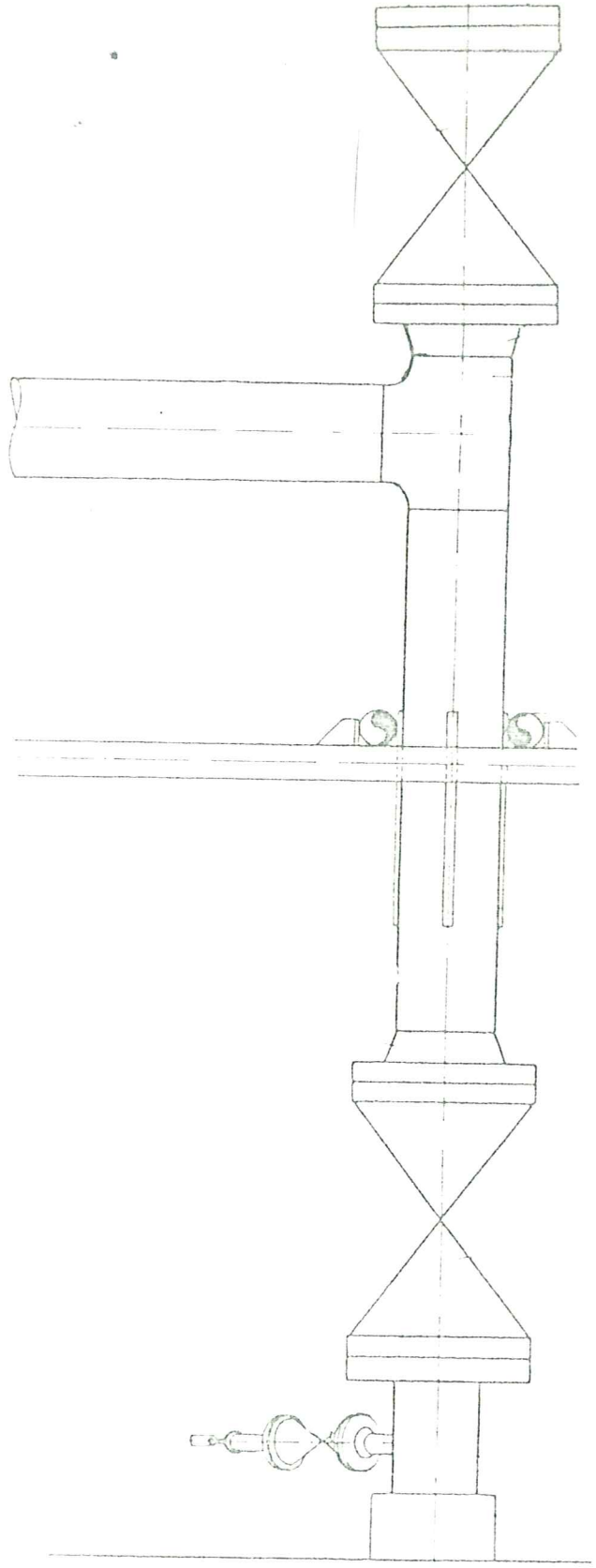
13 3/8" "Pakkdós" (exact estimate not available)	$	30.000 - 111.000
13 3/8" Shaffer SL BOP	$	74.622
Rebuilding of drilling rig, equipment, estimated	$	62.000
Rebuilding of drilling rig, labour cost, estimated	$	30.000
600 meters of 3 1/2" OD slik drill pipe, estimated	$	35.400
100 meters of 3 1/2" OD slik drill collars, estimated	$	14.150
Spool/adapter	$	500
	$	246.672 - 326.672

Fig. 1

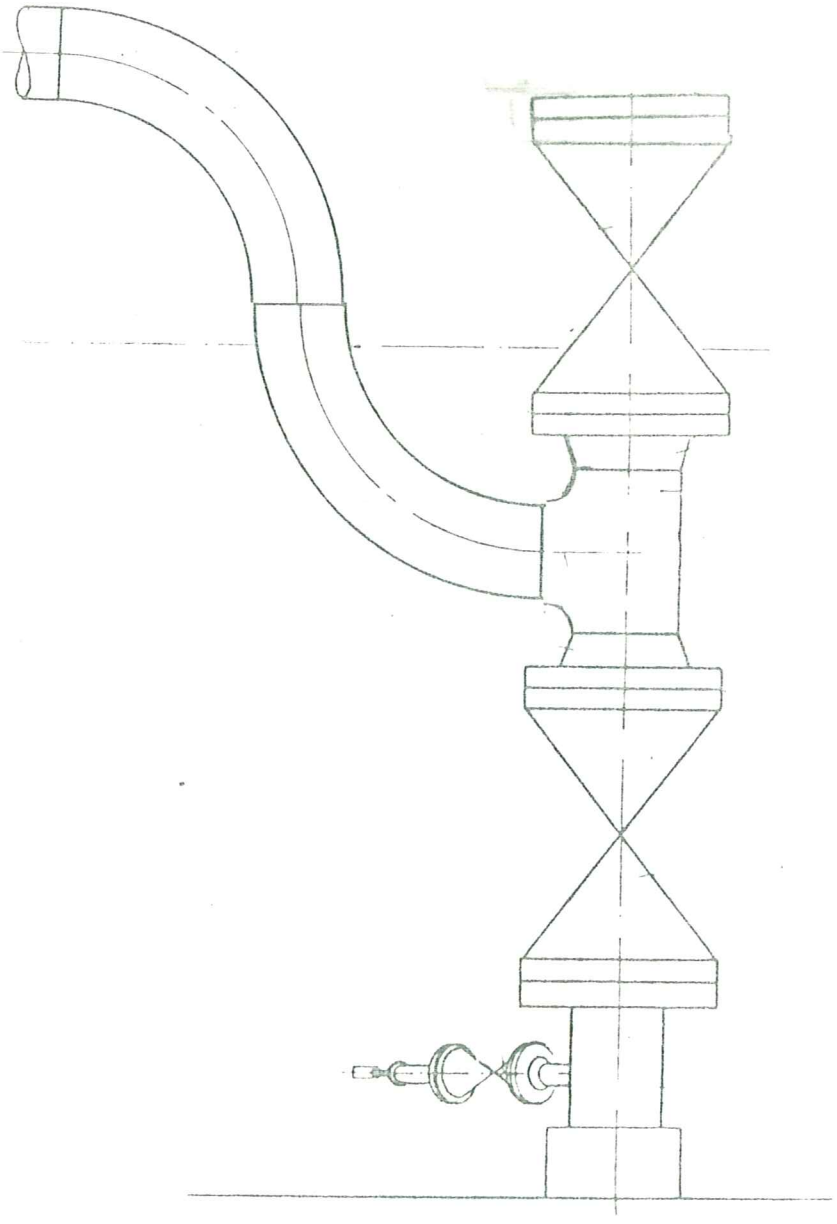


Present Wellhead Design at Svartsengi

Fig. 2

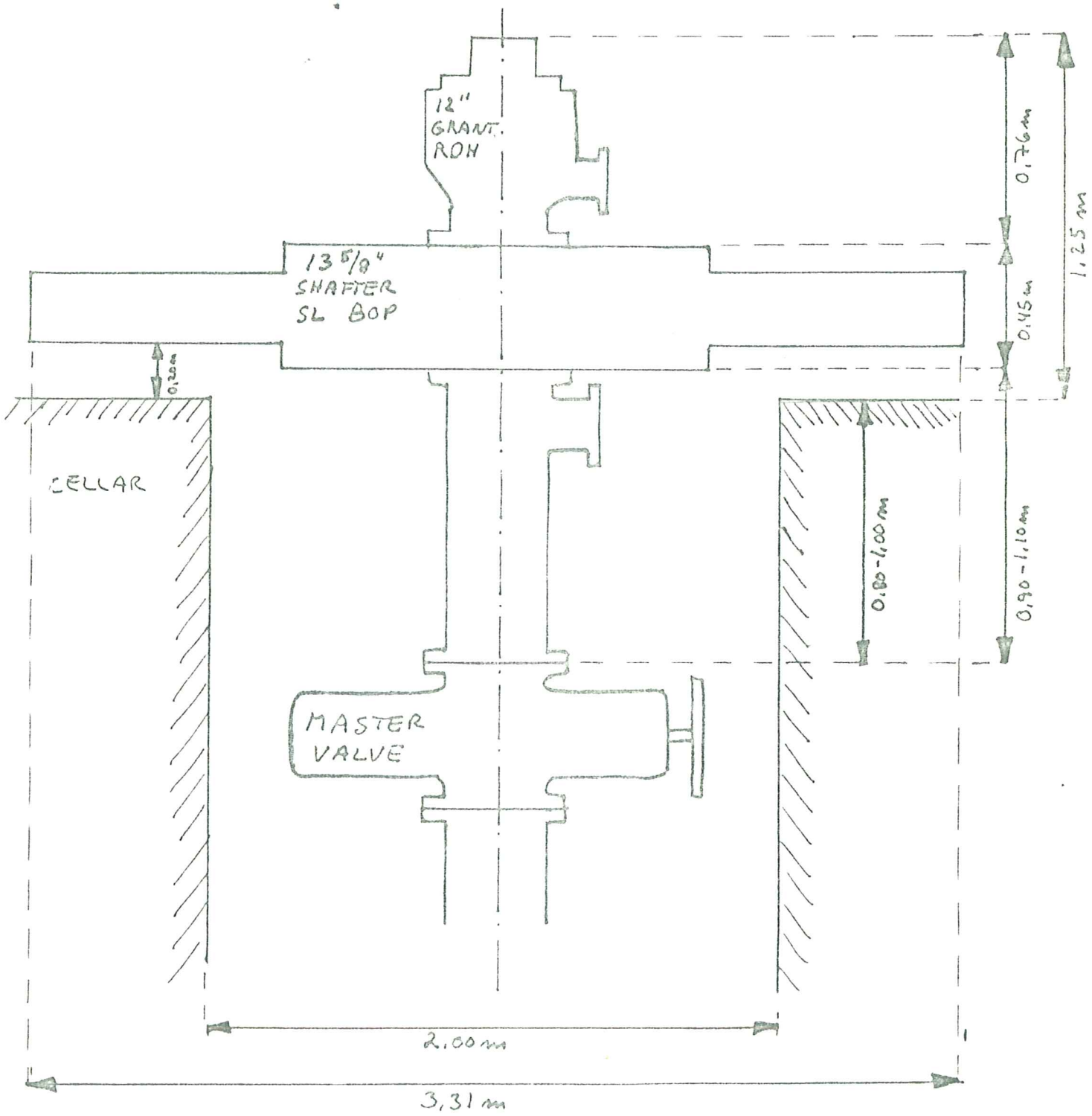


Present wellhead design at Svartsengi with an additional valve on top of flow line outlet, enabling workovers without removal ot top of wellhead



Possible new wellhead design, enabling workovers without removal of top of wellhead.

Fig. 4



Wellhead assembly according to alternattive 1

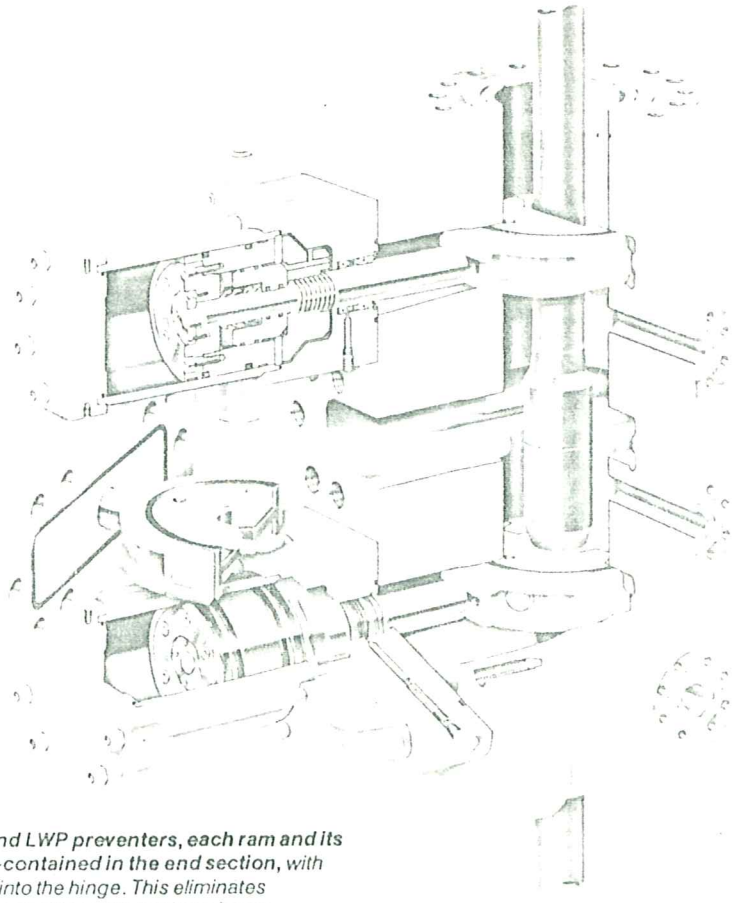
Appendix I

Shaffer, NL Industries, SL BOP-s

SPECIAL FEATURES

Shaffer ram BOP's are world famous for complete reliability in sealing around drill pipe and across open hole, and for shearing drill pipe under all drilling conditions. Some of their outstanding features are:

- **They require a minimum of maintenance space,** and have a low overall height compared to other ram preventers.
- **Single, double and triple models** are available. The double and triple models save space and weight by combining two or three ram compartments into one unitized body.
- **Full environmental H_2S trim,** conforming to API and NACE requirements, is available.
- **Arctic models are available** which meet API specifications for low-temperature service.
- **Self-draining body** has a ram compartment with skids to support the rams and a sloped bottom which allows mud and sand to drain back into the well bore. This keeps the ram cavity free of caked mud and debris so that the rams stay ready for action.
- **Ram rubbers have a long life** in routine drilling operations and in stripping.
- **Ram can be changed easily** without breaking or remaking hydraulic connections, even with pipe in the hole.
- **Single piston hydraulic operators have a minimum number of working parts.** This assures high reliability and low maintenance.
- **Large lip-type piston seals are designed for dynamic service.** They wipe away foreign matter in the cylinder to give exceptionally long, trouble-free service.
- **Flanged, hubbed or studded connections** are available for end connections and side outlets of most models.



On SL (shown above), LWS and LWP preventers, each ram and its operator are completely self-contained in the end section, with all hydraulic connections built into the hinge. This eliminates disconnecting any hydraulic control lines when changing or servicing rams. Rams are easily accessible by unbolting and swinging open the doors. Bottom doors swing out from under the upper cylinders so a hoisting line can be attached directly to the rams for easy handling. Maximum door bolt torque requirements are 6,600 foot pounds.

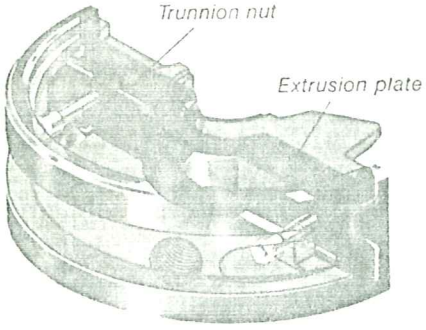
SPECIAL FEATURES

PIPE RAMS — SL, LWS AND LWP BOP'S

- **In most Shaffer rams, two retracting (shoulder) screws secure the ram holder to the ram block** but permit the block to move slightly in the holder to ensure positive alignment of the rubber faces as sealing contact occurs.

- **Model SL, LWS and LWP pipe ram assemblies consist of three major pieces** — the ram block, the ram rubber and the ram holder. The ram rubber is placed on the ram block, then the block and rubber are anchored to the ram holder to make the complete ram assembly.

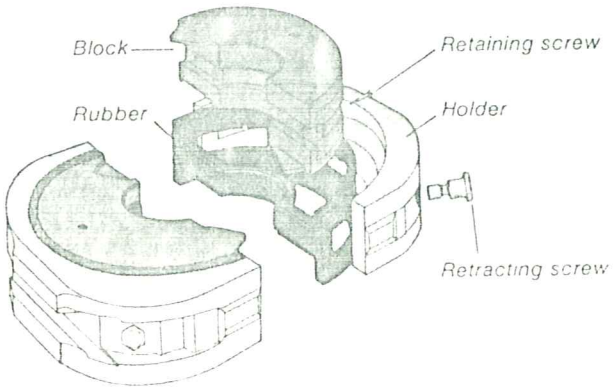
- **The ram rubber is mechanically secured to the block/holder assembly** to keep the rubber in place under extreme pressures. Design of the ram block to ram holder anchoring mechanism permits the block to move slightly in the holder to allow controlled extrusion of the rubber to effect a tighter, more reliable seal.



- **In SL and LWS preventers, the ram rubber is secured to the ram block by two retaining screws** which fit into trunnion nuts. The trunnion nuts extend through holes in the two steel extrusion plates molded into the rubber to control extrusion of the rubber.

- **Continuous, molded ram rubber** has no separation between the semicircular top seal and the horizontal face seal.

- **Rubber compounds** are available for all oil field conditions.



- **Floating rams ensure a positive seal** at low and high pressure, even after ram cavity has been worn by years of service. As the rams close, the following sequence of events occurs:

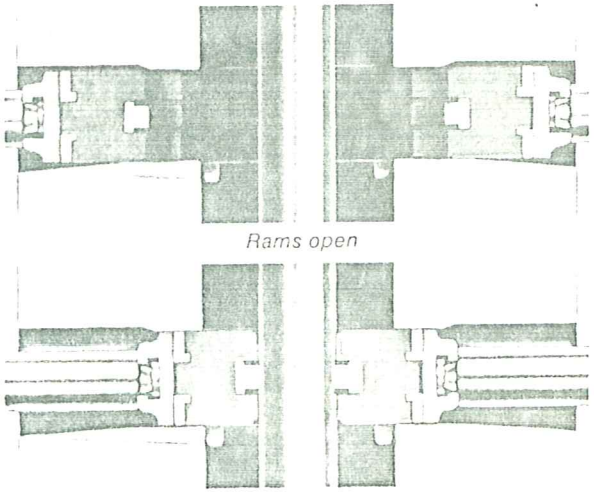
1. The rubber faces contact each other and the pipe.
2. The blocks move slightly to achieve alignment.
3. Further closing movement causes the rubber faces to seal around the drill pipe and against each other. Simultaneously, the ram holder pushes against the semicircular top seal and extrudes it upward to seal against the seat on the BOP body. This effects an initial seal even after years of wear have increased the clearance between seat and block.
4. As well pressure increases, the block moves up and closes the clearance below the seat.

- **Self-centering of pipe** is accomplished by angular guides protruding alternately on top and bottom of ram blocks designed to close around a single string of pipe. This self-centering feature automatically aligns the pipe string with the ram bore, even if the string hangs off-center.

- **Single offset rams** have only one bore, which is offset to API centerline standards. This allows complete control of a dual completion when second string is to be run later.

- **Dual offset rams** are furnished to API centerline standards for complete control of dual completions.

- **Aluminum drill pipe rams** are available for SL, LWS and LWP BOP's. Since aluminum drill pipe has an oversize O.D., these rams must have oversize bores in both the ram blocks and in the ram extrusion plates.



Rams open

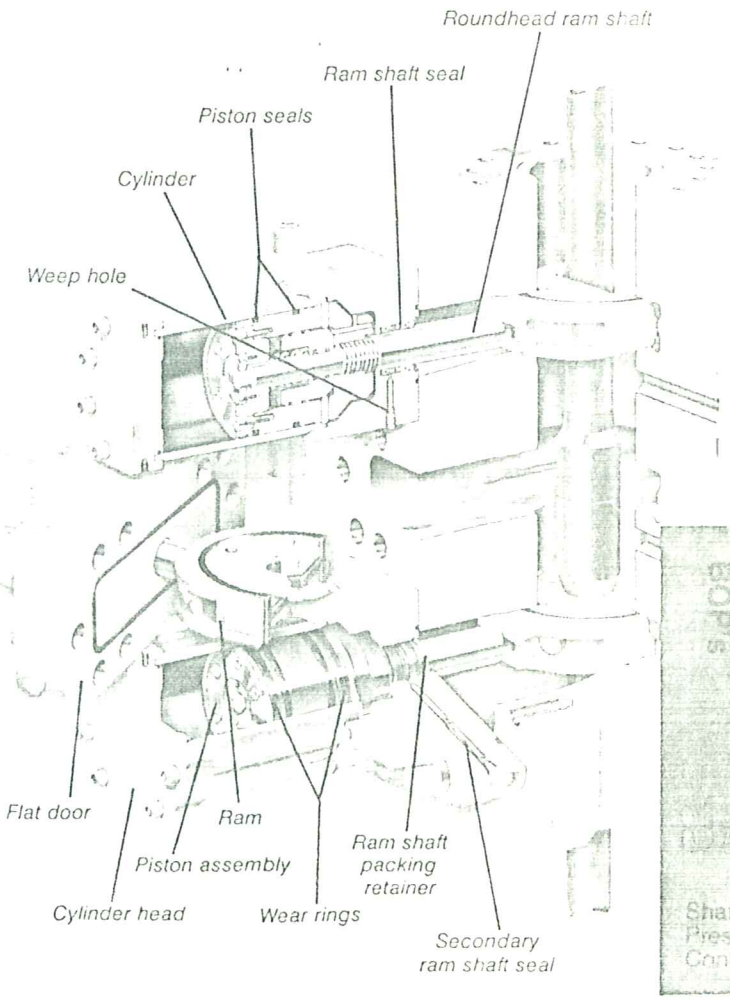
Rams closed

MODEL SL RAM BLOWOUT PREVENTERS

Shaffer Model SL ram blowout preventers are the product of more than 50 years of experience in building ram BOP's to meet the changing demands of the petroleum industry. SL designated models incorporate the improvements made in the LWS preventer line over the past 20 years — improvements resulting from a continuing research program to ensure that Shaffer preventers meet or surpass the latest industry requirements.

SPECIAL FEATURES

- **Flat doors simplify ram changes.** To change the rams, apply opening hydraulic pressure to move the rams to the full open position. Remove the door cap screws and swing the door open. Remove the ram from the ram shaft and replace it. It is not necessary to apply closing hydraulic pressure to move the rams inward to clear the door.
- **Door seals on most sizes have a hard backing** molded into the rubber. This fabric and phenolic backing prevents extrusion and pinching at all pressures to assure long seal life.
- **Internal H_2S trim is standard.** All major components conform to API and NACE H_2S requirements.
- **Maximum ram hardness is Rc22** to insure H_2S compatibility of pipe and blind rams. Shear rams have some harder components.
- **Manual-lock and Poslock pistons can be interchanged** on the same door by replacing the ram shaft, piston assembly and cylinder head.
- **Wear rings eliminate metal-to-metal contact** between the piston and cylinder to increase seal life and virtually eliminate cylinder bore wear.
- **Lip type piston seals are long-wearing polyurethane** with molybdenum disulfide molded in for lifetime lubrication.
- **Lip-type ram shaft seals hold the well bore pressure and the opening hydraulic pressure.** No known failures of this highly reliable high-pressure seal have occurred.
- **Secondary ram shaft seals permit injection of plastic packing** if the primary lip-type seal ever fails. Fluid dripping from the weep hole in the door indicates that the primary seal is leaking and the secondary seal should be energized.
- **Rams are available which will support a 600,000 pound drill string** when a tool joint is lowered onto the closed rams. These rams conform to H_2S requirements.
- **Shear rams cut drill pipe and seal in one operation.** Most common weights and grades of drill pipe are sheared with less than 1,500 psi hydraulic pressure.
- **Poslock operators automatically lock the rams each time they are closed.** This eliminates the cost of a second hydraulic function to lock. It also simplifies emergency operation because the rams are both closed and locked just by activating the close function.



OPERATION AND MAINTENANCE

MODEL SL HYDRAULIC SYSTEM

Hydraulic power to operate a Model SL ram BOP can be furnished by any standard oil field accumulator system.

Hydraulic passages drilled through the body eliminate the need for external manifold pipes between the hinges. Each set of rams requires only one opening and one closing line. There are two opening and two closing hydraulic ports, clearly marked, on the back side of the BOP. The extra hydraulic ports facilitate connecting the control system to the preventer.

A 1,500-psi-output hydraulic accumulator will close any Model SL ram BOP with rated working pressure in the well bore except for the 11" and 13⅝"-15,000 psi BOP's, which require 2,100 psi. However, these two will close against 10,000 psi well pressure with less than 1,500 psi hydraulic pressure.

A 3,000 psi hydraulic pressure may be used, but this will accelerate wear of the piston seals and the ram rubbers.

A 5,000 psi hydraulic pressure test is applied to all Model SL cylinders at the factory. However, it is recommended that this pressure not be used in the field application.

The hydraulic operating fluid should be hydraulic oil with a viscosity between 200 and 300 SSU at 100°F. If necessary, a water-soluble oil such as NL Rig Equipment K-90 and water can be used for environmental protection. Ethylene glycol must be added to the K-90 and water solution for freeze protection if equipment is exposed to freezing temperatures.

NOTE: Never use fuel oil of any kind as it causes the rubber goods to swell and deteriorate. Some water-soluble fluids do not give adequate corrosion protection or lubrication and should not be used.

MODEL SL POSLOCK SYSTEM

SL preventers equipped with Poslock pistons are automatically locked in the closed position each time they are closed. The preventers will remain locked in the closed position even if closing pressure is removed. Opening hydraulic pressure is required to reopen the pistons.

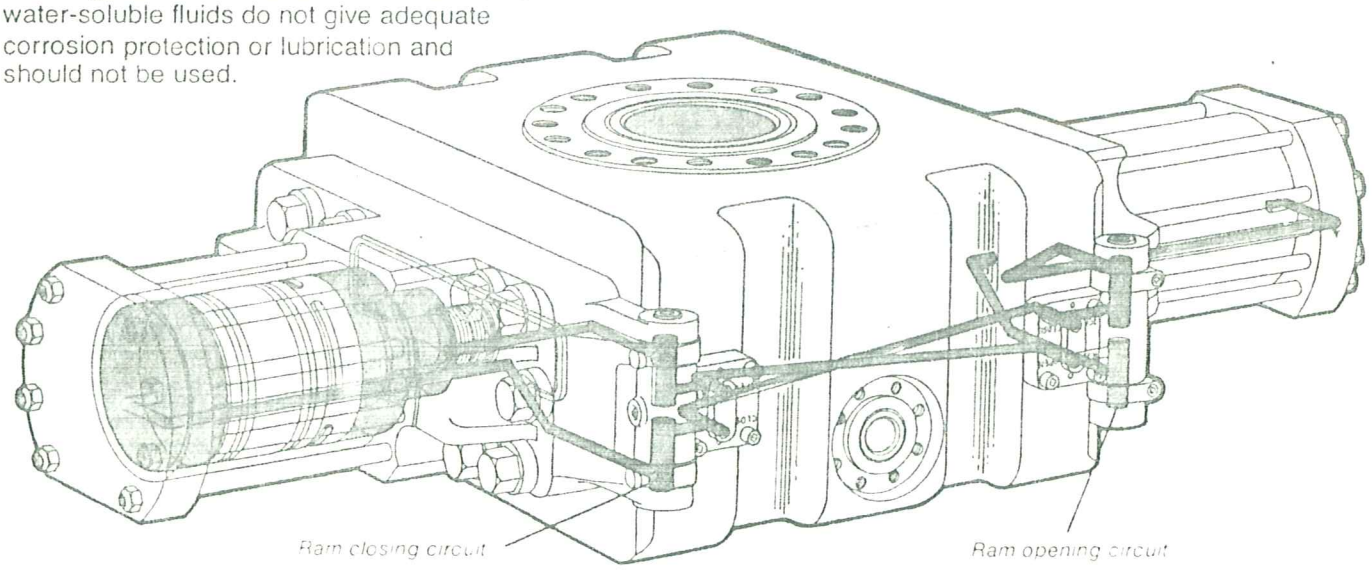
The hydraulics required to operate the Poslock are provided through opening and closing operating ports. Operation of the Poslock requires no additional hydraulic functions, such as are required in some competitive ram locking systems.

When closing hydraulic pressure is applied, the complete piston assembly moves inward and pushes the rams into the well bore. As the piston reaches the fully closed position, the locking segments slide toward the piston O.D. over the locking shoulder as the locking cone is forced inward by the closing hydraulic pressure.

The locking cone holds the locking segments in position and is prevented by a spring from vibrating outward if the hydraulic closing pressure is removed. Actually, the locking cone is a second piston inside the main piston. It is forced inward by closing hydraulic pressure and outward by opening hydraulic pressure.

When opening hydraulic pressure is applied, the locking cone moves outward and the locking segments slide toward the piston I.D. along the tapered locking shoulder. The piston is then free to move outward and open the rams.

NOTE: Poslock pistons are adjusted in the factory and normally do not require adjustment in the field except when changing between pipe rams and shear rams. The adjustment is easy to check and easy to change.



OPERATION AND MAINTENANCE

MODEL SL RAMS

Improved Model SL rams are designed to last longer. Ram rubbers receive most of their wear during routine closing and pressure testing. To simulate this, Model SL rams were installed in BOP's, closed, pressure tested to working pressure, opened and retested for hundreds of cycles. Test details are available on request.

Model SL extrusion plates extend vertically to support the sides of the ram rubber, as shown below. This securely anchors the rubber next to the ram block and reduces wear at this point.

Wide vertical faces give additional ram rubber strength for longer life in 10,000 psi and higher working pressures, as shown below.

Model SL round-head ram shaft accepts Model LWS rams on all sizes which replace an LWS BOP so that spare rams can be used, except on 11"-10,000 psi BOP.

Round-head ram shaft can be repacked without disassembling door. Make sure rams are in fully open position, then proceed as follows:

1. Open the door and remove the ram.
2. Remove the ram shaft packing retainer (snap ring).
3. Remove weep hole plug and plug weep hole with a pipe plug.
4. Apply low hydraulic opening pressure to pump both the well-pressure packing and the hydraulic-pressure packing out of the door.
5. Repack the ram shaft.
6. Remove plug from weep hole and reinstall weep hole plug.

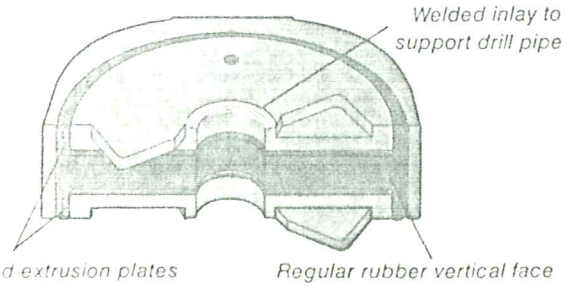
Model SL rams mount horizontally on all SL preventers except 15,000 psi working pressure models, on which they mount vertically. The double-button-head mounting design is necessary for added strength in the 15,000 psi application.

Model SL rams are for regular duty. They do not have the hard inlay around the pipe bore and will not support drill pipe on the 18° tool joint taper. Otherwise, Model SL and SL-D rams are identical.

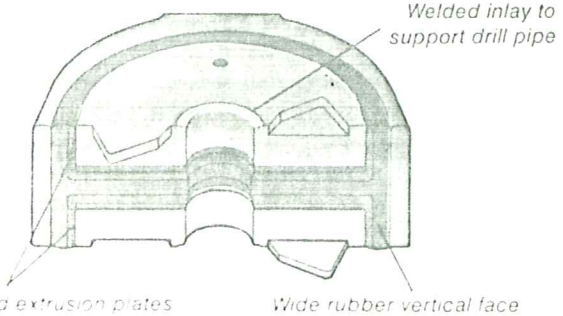
Model SL-D rams will support a 600,000-pound drill string load when a tool joint is lowered onto the closed rams. These rams comply with API and NACE H_2S specifications. A patented,* H_2S-compatible, hard inlay is welded around the pipe bore, as shown below, to cut into the 18° taper on the bottom of the tool joint and form a supporting shoulder. The remainder of the ram block is alloy steel with hardness below R_c22.

A square-shouldered hang-off tool allows Model SL rams to support drill pipe by eliminating the 18° tool joint taper. The hang-off tool also eliminates damage to the 18° taper on the tool joint and will extend the life of Model SL-D rams if repeated hang-offs are planned.

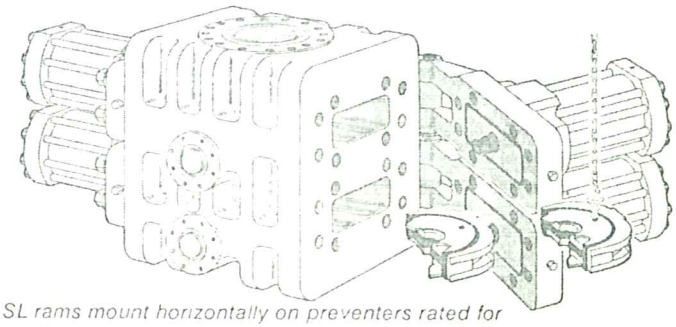
*U.S. Patent No. 3,880,436.



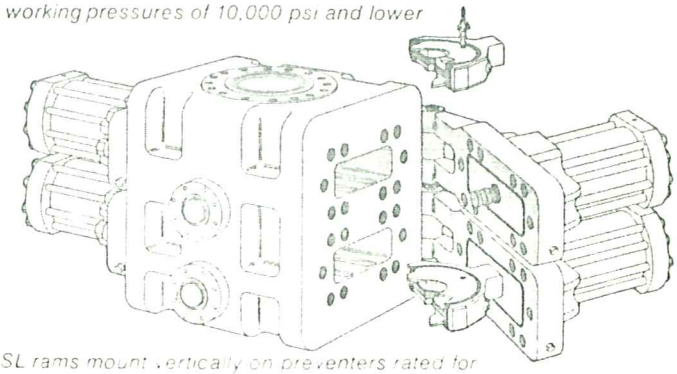
SL-D ram for working pressures of 5,000 psi and lower



SL-D ram for working pressures of 10,000 psi and higher



SL rams mount horizontally on preventers rated for working pressures of 10,000 psi and lower



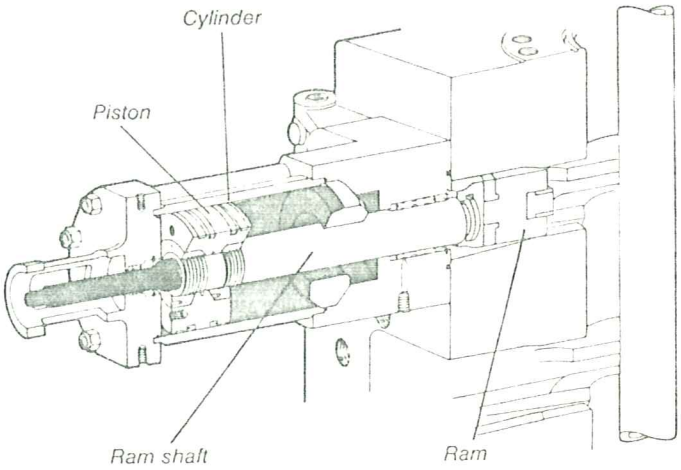
SL rams mount vertically on preventers rated for working pressures of 15,000 psi

MODEL SL MANUAL-LOCK SYSTEM

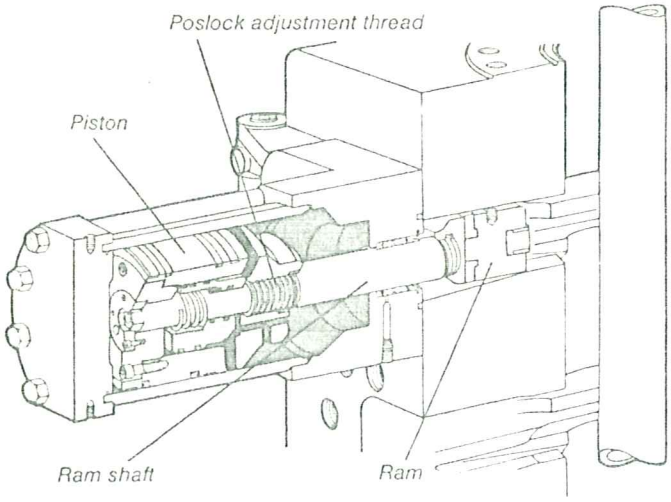
Manual-lock pistons move inward and close the rams when closing hydraulic pressure is applied. If desired, the rams can be manually locked in the closed position by turning each locking shaft to the right until it shoulders against the cylinder head. Should hydraulic pressure fail, the rams can be manually closed and locked. They cannot be manually reopened.

The manual locking shafts are visible from outside and provide a convenient ram position indicator. Threads on the manual locking shaft are enclosed in the hydraulic fluid and are not exposed to corrosion from mud and salt water or to freezing.

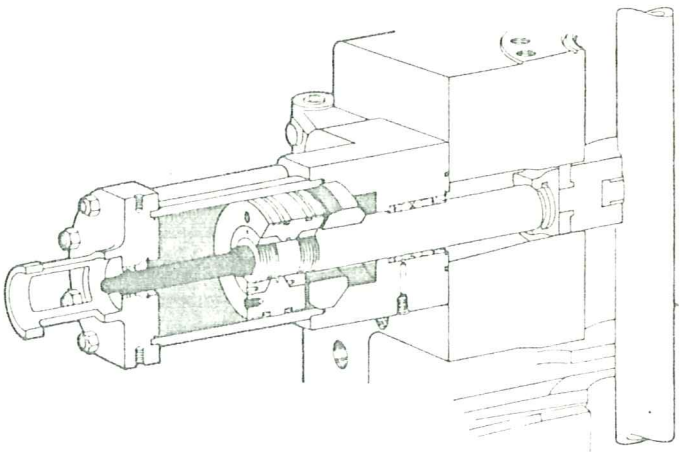
Rams are opened by first turning both locking shafts to their "unlocked" position, then applying opening hydraulic pressure to the pistons, which move outward and pull the rams out of the well bore.



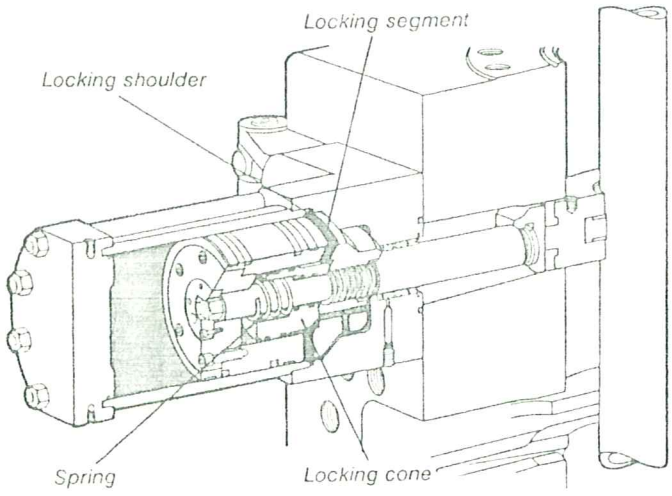
Manual-lock piston in open position



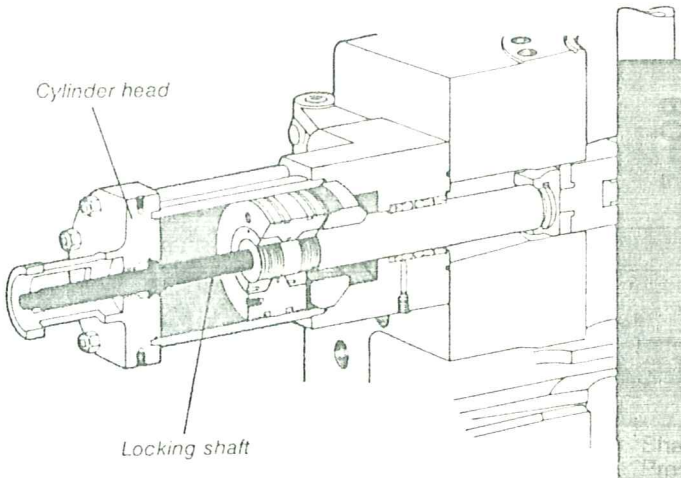
Poslock piston in open position



Manual-lock piston in closed position



Poslock piston in closed position



Manual-lock piston in closed and locked position

CAPACITIES AND DIMENSIONS

MODEL SL POSLOCK AND MANUAL-LOCK SPECIFICATIONS

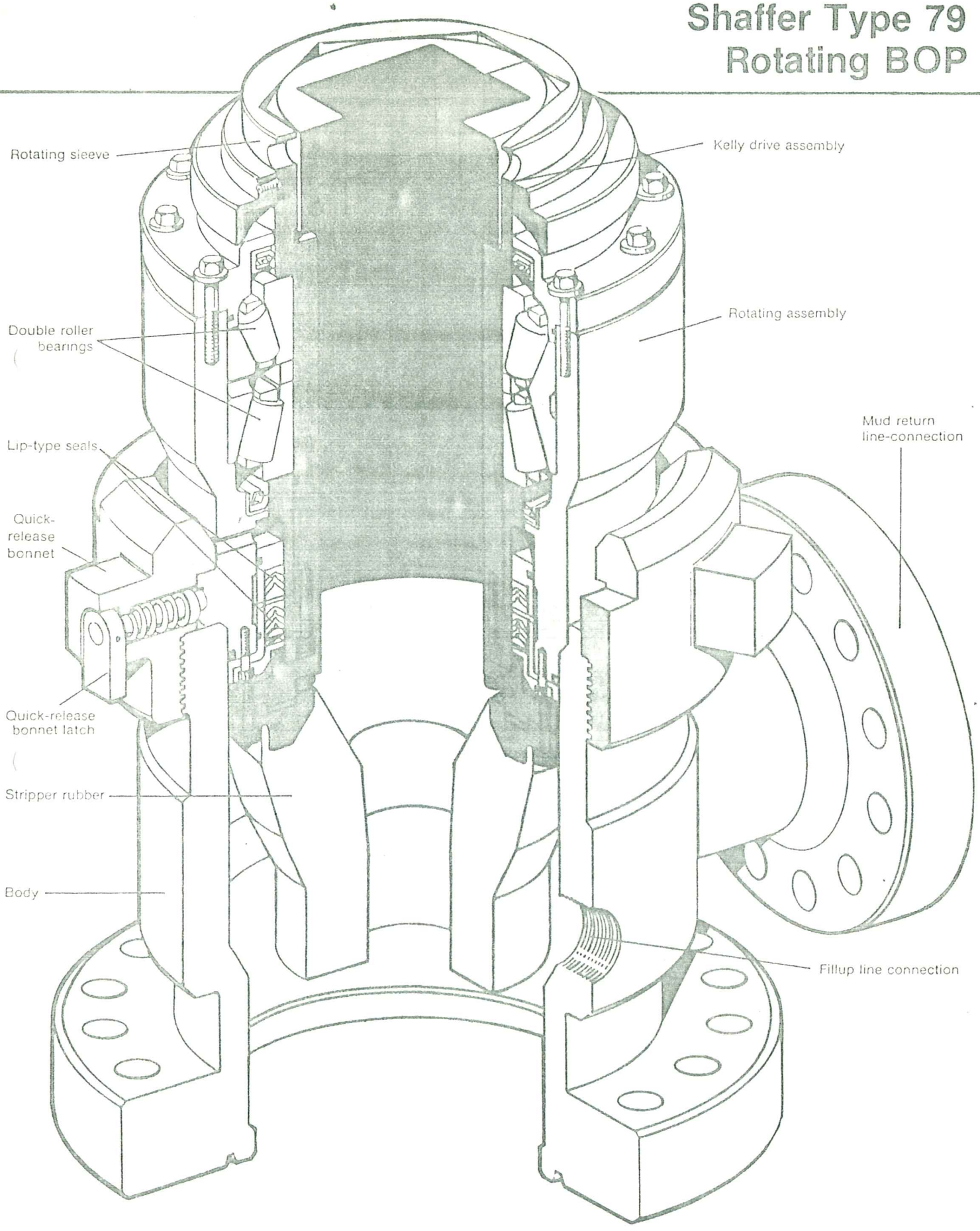
Working Pressure (psi)			15,000				10,000					5,000				3,000
Bore (in.)			13 5/8	11	7 1/16	7 1/16	21 1/4	18 3/4	16 3/4	13 5/8	11	16 3/4	16 3/4	13 5/8	13 5/8	13 5/8
Model			SL	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL
Piston Size (in.)			14	14	10	14	14	14	14	14	14	10	14	10	14	10
Poslock	L (Length, in.)		123	115 7/16	79	92 1/4	136 1/4	129 3/8	127 1/4	109	102 3/8	116 1/2	118 3/4	105 3/4	108	....
	F (in.)		41 11/16	39 51/64	28 1/8	34 1/8	42 1/16	42 1/8	42 1/8	37 3/4	36 1/16	37 3/4	39 7/16	35 1/16	37 3/8	....
	G (in.)		77 1/4	71 13/16	48 7/8	54 7/8	84 1/8	81	79 5/16	65 11/16	62 1/8	69 3/4	71 11/16	62 11/32	64 3/8	....
Manual-Lock	L (Length, in.)		142 3/4	135 7/32	79	....	....	....	....	128 3/4	122 3/4	141 1/2	....	130 1/4	....	130 1/4
	F (in.)		44 1/2	42 17/64	25 1/4	....	....	....	....	40 1/8	39 1/2	43 3/16	....	41 1/16	....	41 1/16
	G (in.)		80 1/8	74 21/64	46	....	....	....	....	68 3/4	65	75 1/4	....	68 1/16	....	68 1/16
W (Width, in.)			48 1/8	46 7/8	30 1/8	30 1/8	53 15/16	56 7/8	55 1/8	41	37 3/8	46 1/2	40 1/2	35 1/8	35 1/8	35 1/8
H (Height, in.)	Single:	Studded	38 1/2	33 1/2	22 7/8	22 7/8	40	36 11/16	33 1/2	28	23 1/2	25	25	17 1/4	17 1/4	17 1/4
		Flanged	64 1/2	57	39 1/4	39 1/4	69 1/2	60 1/4	55 7/8	48 1/8	42 3/4	43 1/2	43 1/2	33 3/8	33 3/8	30 3/8
		Hubbed	....	....	....	....	....	51 15/16	49 1/2	38 7/8	....	37 3/4	37 3/4	29 1/4	29 1/4	....
	Double:	Studded	58 1/4	52	36 5/8	....	59 1/4	54 3/4	51 3/4	46	40 1/8	42 1/8	42 1/8	34	34	34
		Flanged	84 1/4	75 1/2	53	....	88 3/4	78 7/16	74 1/8	66 1/8	60 1/4	61 1/8	61 1/8	50 3/8	50 3/8	47 3/8
		Hubbed	....	....	....	....	[illegible]	69 3/4	65 3/4	56 7/8		55 1/8	55 1/8	46	46	....
	Triple:	Flanged	....	....	....	....	....	97 5/16	....	....	....				....	....
		Hubbed	....	....	....	....	....	89	....	....	....					....
D (in.)			18 7/8	19 1/2	12 1/2	12 1/2	22 7/8	26 1/8	25 1/4	17 7/8	16	21 1/8	21 1/8	13 3/4	13 3/4	13 3/4
E (in.)			30	27 3/8	17 7/8	17 7/8	31 7/16	30 3/4	29 7/8	23 7/16	21 7/8	24 1/2	24 1/2	21 3/8	21 3/8	21 3/8
I (in.)			19 3/4	18 1/2	13 3/4	13 3/4	19 1/4	19 1/4	19 1/4	18	17 3/8	17 3/4	17 1/4	16 3/4	16 3/4	16 3/4
J (in.)			11 1/4	11	8 3/4	8 3/4	15 1/4	11 1/4	11 1/4	11 1/2	11 3/8	12 1/8	12 3/8	12 1/4	12 1/4	12 1/4
K (in.)	Single:	Studded	12 1/2	10 7/16	4 11/16	4 11/16	13 3/8	11 7/8	10 1/8	8 1/8	6 1/4	[illegible]	[illegible]	4 3/8	4 3/8	4 3/8
		Flanged	25 1/2	22 3/16	12 7/8	12 7/8	28 1/8	23 1/2	21 5/16	18 3/16	[illegible]	[illegible]	[illegible]	12 7/16	12 7/16	11 7/16
		Hubbed	....	....	....	....	....	19 7/8	....	13 5/16	....	12 1/2	12 1/2	10 3/8	10 3/8	....
	Double:	Studded	12 1/2	10 7/16	4 11/16	....	13 3/8	11 7/8	9 7/8	8 1/8	6 1/4	[illegible]	[illegible]	4 3/8	4 3/8	4 3/8
		Flanged	25 1/2	22 3/16	12 7/8	....	28 1/8	22 23/32	20 13/16	18 3/16	15 7/16	15 3/8	15 3/8	12 7/16	12 7/16	11 7/16
		Hubbed	....	....	....	....	....	18 5/8	17 1/8	13 9/16		12 1/2	12 1/2	10 3/8	10 3/8	
	Triple:	Flanged	....	....	....	....	....	22 23/32	....	....						
		Hubbed	....	....	....	....	....	18 1/8	....	....					....	....
M (in.)	Single:	Studded	15	13	8 15/16	8 15/16	16	14 7/16	12 3/4	10 3/4	8 3/4	9 3/4	9 3/4	6 3/8	6 3/8	6 3/8
		Flanged	28	24 3/4	17 1/8	17 1/8	31 1/16	26 13/32	23 11/16	20 13/16	18 7/16	19	19	14 7/16	14 7/16	13 7/16
		Hubbed	....	....	....	....	....	22 1/4	20 3/4	16 5/16	....	16 1/8	16 1/8	12 3/8	12 3/8	....
	Double:	Studded	15	13	8 15/16	....	16	13 3/4	12 1/4	10 3/4	8 3/4	9 3/4	9 3/4	6 3/8	6 3/8	6 3/8
		Flanged	28	24 3/4	17 1/8	....	31 1/16	26 13/32	23 11/16	20 13/16	18 7/16	19	19	14 7/16	14 7/16	13 7/16
		Hubbed	....	....	....	....	....	21 1/4	20 3/4	16 7/16	....	16 1/8	16 1/8	12 3/8	12 3/8	....
	Triple:	Flanged	....	....	....	....	....	25 13/32	....	....	....	....	....	....	....	....
		Hubbed	....	....	....	....	....	21 1/4	....	....	....	....	....	....	....	....
N (in.)			8 1/2	7 1/2	5	5	8	8	8	6 1/2	6	5 1/2	5 1/2	4 1/2	4 1/4	4 1/2
O (in.)*	2-inch		....	33 1/2	19	19	36 1/2	33 1/8	32 1/2		24 7/16	25 7/16	28 1/16	22 3/4	22 3/4	23 11/16
	3-inch			....	19	19	37 1/2	34 3/8	33 1/2	28 11/16	25 1/8	[illegible]	28 1/16	24 3/8	24 3/8	23 1/8
	4-inch		35 7/16	35 9/16	....	....	38 1/4	35 1/8	34 1/4	29 1/4	26 7/8	[illegible]	[illegible]	22 3/4	22 3/4	23 1/2
P (in.)*	2-inch		....	30 1/2	20 13/16	20 13/16	35 7/8	33 1/4	32 3/8		24 7/16	28 7/16	28 7/16	22 3/4	22 3/4	23 11/16
	3-inch			....	21 3/4	21 3/4	36 7/8	34 1/4	33 3/8	[illegible]	25 1/8	28 7/16	28 7/16	24 3/8	24 3/8	23 1/8
	4-inch		34 11/16	32 9/16	....	....	37 3/8	35	34 1/8	29 1/4	26 9/16	[illegible]	28 3/16	22 3/4	22 3/4	23 1/2
Weight (Total, lbs.) Without Rams	Single:	Studded†	25,860	21,640	5,550	6,900	31,130	26,432	25,828	13,460	11,427	14,095	....	7,995	9,125	7,939
		Flanged	29,050	24,655	6,200	7,550	37,285	30,700	28,420	15,295	12,695	15,460	....	8,985	10,110	8,430
		Hubbed	....	....	....	....	31,800	27,114	26,565	13,590	11,708	14,700	....	8,288	9,415	7,924
	Double:	Studded†	41,940	34,730	9,600	12,350	48,705	44,224	41,200	23,530	20,510	25,285	....	15,620	17,875	15,563
		Flanged	45,130	37,750	10,250	12,950	54,860	48,488	43,790	25,365	21,780	26,648	....	16,608	18,860	16,054
		Hubbed	....	....	....	....	49,372	44,093	41,935	23,660	21,790	25,806	....	15,912	18,165	15,548
Weight (Break-down, lbs.)	1 Ram Assembly with Holders		523	381	150	150	551	589	527	504	366	255	....	334	334	334
	Door Assembly (1 each)		3,790	3,400	1,100	1,900	3,385	3,357	3,347	2,675	2,595	2,612		1,862	2,425	1,862
	Body — Single	Studded	17,435	14,237	2,950	2,950	22,920	18,652	18,558	7,625	5,932	8,570	8,570	4,040	4,040	4,040
		Flanged	21,470	17,855	3,750	3,750	30,515	23,985	21,725	9,945	7,505	10,235	10,235	5,260	5,260	4,706
		Hubbed	....	....	....	....	25,030	20,400	19,870	8,240	6,518	9,475	9,475	4,564	4,654	4,200
	Body — Double	Studded	25,935	20,530	4,600	4,600	33,725	29,730	27,234	12,345	9,825	14,536	14,536	7,940	7,940	7,940
		Flanged	29,970	24,148	5,400	5,400	41,320	35,060	30,400	14,665	11,400	16,200	16,200	9,160	9,160	8,606
		Hubbed	....	....	....	....	35,832	31,475	28,547	12,960	10,411	15,438	15,438	8,464	8,464	8,100
Closing Ratio			7.11	7.11	7.11	13.94	7.11	7.11	7.11	7.11	7.11	5.54	10.85	5.54	10.85	5.54
Opening Ratio			2.14	2.8	3.37	7.14	1.63	1.83	2.06	4.29	7.62	2.03	5.77	3.00	10.02	3.00
Gallons to Close			11.56	9.4	2.72	6.00	16.05	14.55	14.47	10.58	9.45	6.07	11.76	5.44	11.00	5.44
Gallons to Open			10.52	8.1	2.34	5.57	13.86	13.21	12.50	10.52	7.0	4.97	10.67	4.46	10.52	4.46
Maximum Ram Size (in.)			10 3/4	8 5/8	5 1/2	5 1/2	16	16	13 5/8	10 3/4	8 5/8	13 3/8	13 3/8	10 3/4	10 3/4	10 3/4
Door Screw	Across Flats (in.)		3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8
	Torque (ft.-lb.)		6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600

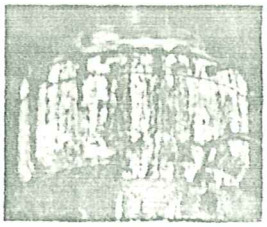
*For flanged side outlets. Studded [illegible] side outlets are shorter.
†Includes studs and nuts.

Appendix II

Shaffer, NL INdustries, Type 79 Rotating BOP

The New Shaffer Type 79 Rotating BOP





Short, fast, handy--take one for a spin.

The compact Shaffer Type 79 rotating blowout preventer makes short work of pressure control. It stands as low as 36 inches, yet gives nothing away to bulkier preventers in dependability, versatility and easy operation—customer-demanded features that have marked Shaffer rotating BOPs since the first one hit the oil patch in the early '30s.

Fast changes are routine with the Shaffer Type 79. A quick-release bonnet makes it simple to switch between rotating asembly, stationary pipe stripper and bell nipple extension, or to pull the rotating assembly to change the drill bit or stripper rubber. Opening the latch and turning the bonnet one-sixth turn to the left releases the rotating assembly, which can then be lifted out of the body. This opens up the full bore of the body for removal of the drill bit. When the rotating assembly is replaced in the body, one-sixth turn of the bonnet to the right locks the assembly in place.

You won't find a handier preventer anywhere. The Type 79 can be used for drilling in areas susceptible to kicks or blowouts, drilling under pressure, drilling with reverse circulation and circulating with gas or air. It lets you drill with well bore pressures up to 500 psi at 100 rpm and strip pipe into or out of the hole at pressures up to 1,000 psi with the stationary pipe stripper.

Long on wear on any type pipe

Operation of the Type 79 is very simple. The kelly rotates the kelly drive assembly, which turns the rotating sleeve and the stripper rubber attached to it. Reliable seals encircle the rotating sleeve, which turns smoothly in double roller bearings. The long-wearing stripper rubber seals tightly around kelly, drill pipe, drill collar, tubing or casing. During drilling, the stripper rubber rotates with the drill string, so the only wearing action on the rubber is the drill pipe and kelly sliding through as hole is made. While tripping in or tripping out, the rubber expands to let tool joints or pipe couplings through without losing its seal. You're always in control since the seal grows tighter as well pressure increases.

Automatic lubrication ensures long life

An automatic, field-proven lubricating system ensures a long service life for the rotating seal assembly by continuously lubricating it during drilling. The system's compact pump operates on 50-100 psi of air pressure, weighs only five pounds and mounts easily on a vertical or horizontal drum of lubricant. For ambient temperatures of 40-90° F, a 30-weight, non-detergent oil or equivalent is the recommended lubricant.

Installation is a snap

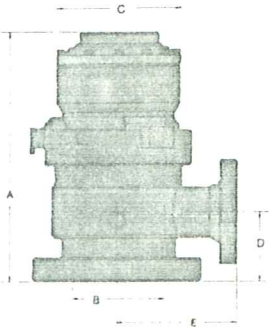
Easy installation is another of the Type 79's strong points. The body bolts to the top of your BOP stack with the flanged side outlet connected to the mud return line. Fillup lines can be connected easily to a pair of threaded 2-inch holes in the body.

Stay-in-control service

Whenever you need routine service or emergency assistance, a factory-trained NL Rig Equipment service representative is just a call away. Any day—or night, anywhere in the world, we're ready to move fast to keep your Shaffer BOP in condition to keep you in control.

Shaffer Type 79 rotating BOP specifications

The Type 79 rotating blowout preventer comes in the six models shown in the table below. Stripper rubbers are available in various sizes to match your specific needs. All parts, except the body, are totally interchangeable among the six models.



TYPE 79 ROTATING BOP DIMENSIONAL DATA

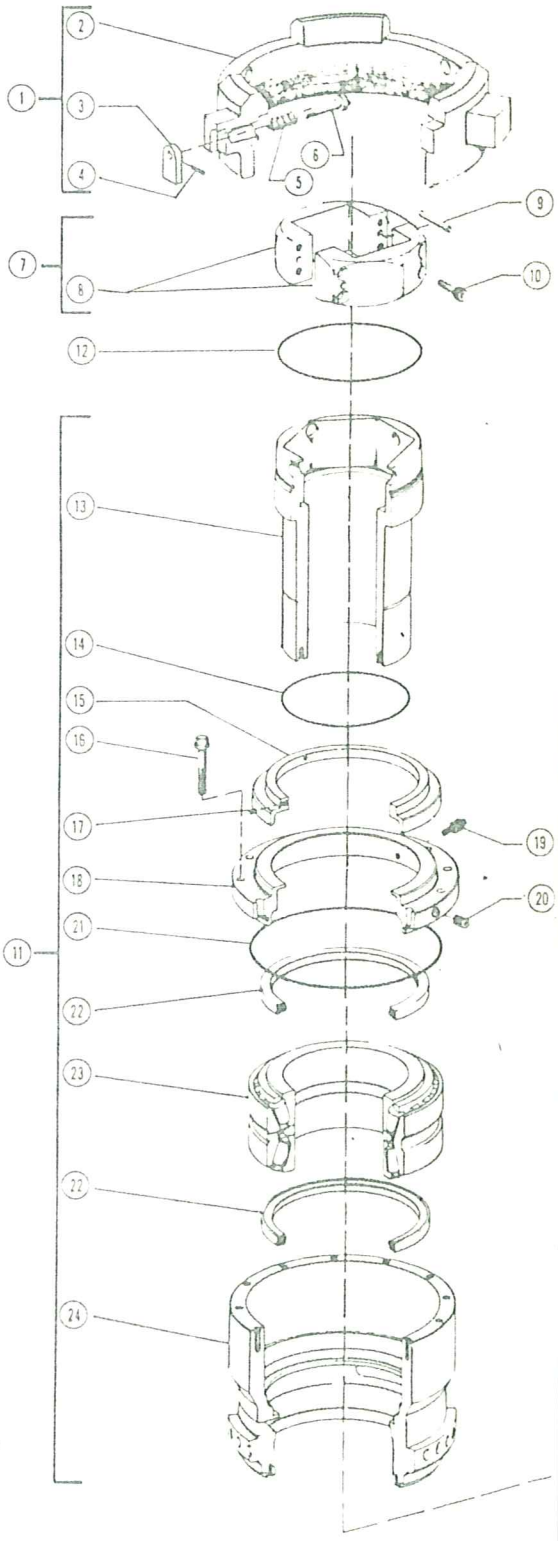
API Bottom Flange Size	Approx. Weight (lb.)	A (in.)	B (in.)	C (in.)	D (in.)	E (in.)
11"—3,000 psi	1,660	36	11	17⅞	11⅞	18
11"—5,000 psi	1,790	38¼	11	17⅞	13⅞	18
11"—10,000 psi	2,095	39	11	17⅞	14⅞	19
13⅝"—3,000 psi	1,720	36	13⅛	17⅞	11⅞	18
13⅝"—5,000 psi	1,950	37	13⅛	17⅞	12⅞	19
13⅝"—10,000 psi	2,500	40½	13⅛	17⅞	15⅛	21

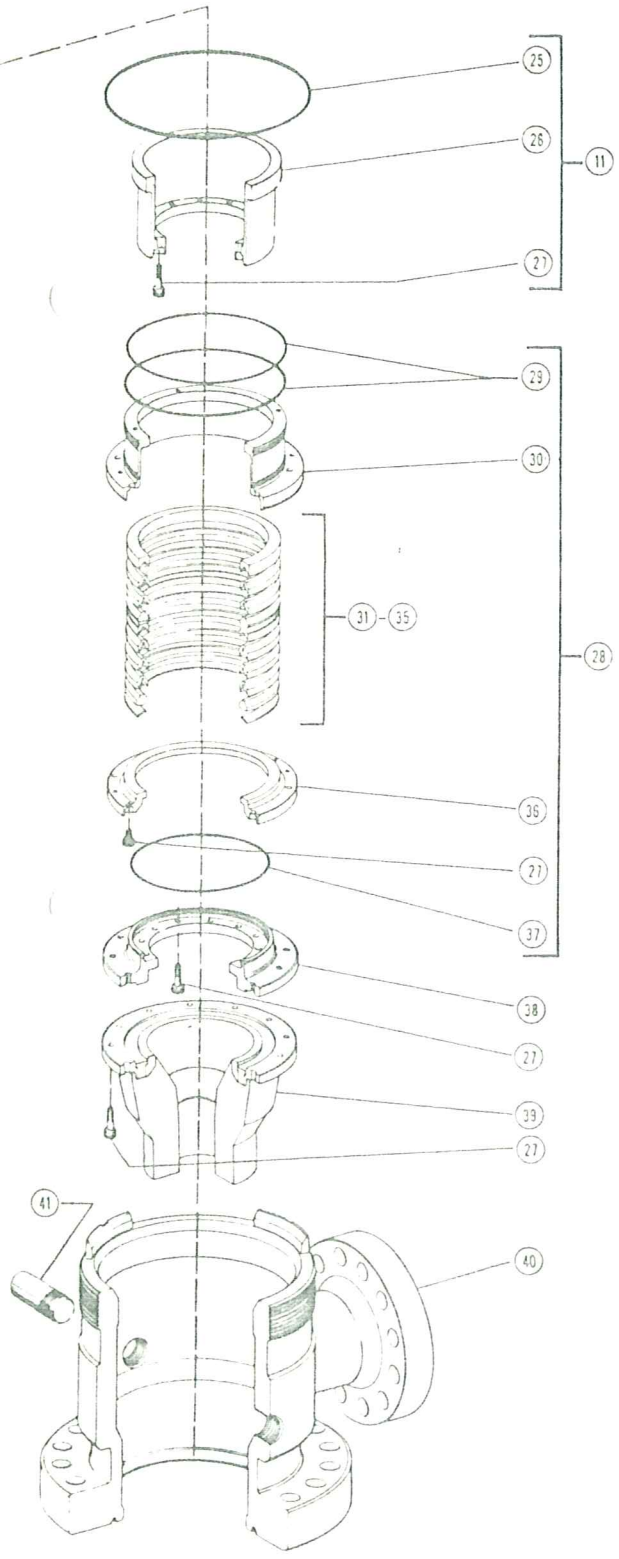
TABLE 1—COMPLETE ASSEMBLY

API Bottom Flange Size	Bore (in.)	Side Outlet Flange Size	Fillup Holes Nom. I.P. (in.)	Complete Assembly Part Number	Trim
11"—3,000 psi	11	7⅛"—3,000 psi	2	147560	Standard & Internal H_2S
		9"—3,000 psi	2	147564	Standard & Internal H_2S
		7⅛"—3,000 psi	2	....	Arctic & Internal H_2S
		9"—3,000 psi	2	147496	Arctic & Internal H_2S
11"—5,000 psi	11	7⅛"—3,000 psi	2	147568	Standard & Internal H_2S
		9"—3,000 psi	2	147571	Standard & Internal H_2S
		7⅛"—3,000 psi	2	....	Arctic & Internal H_2S
		9"—3,000 psi	2	147484	Arctic & Internal H_2S
11"—10,000 psi	11	7⅛"—3,000 psi	2	147515	Standard & Internal H_2S
		9"—3,000 psi	2	147574	Standard & Internal H_2S
		7⅛"—3,000 psi	2	....	Arctic & Internal H_2S
		9"—3,000 psi	2	....	Arctic & Internal H_2S
13⅝"—3,000 psi	13⅝	7⅛"—3,000 psi	2	147366	Standard & Internal H_2S
		9"—3,000 psi	2	147580	Standard & Internal H_2S
		7⅛"—3,000 psi	2	....	Arctic & Internal H_2S
		9"—3,000 psi	2	....	Arctic & Internal H_2S
13⅝"—5,000 psi	13⅝	7⅛"—3,000 psi	2	147583	Standard & Internal H_2S
		9"—3,000 psi	2	147588	Standard & Internal H_2S
		7⅛"—3,000 psi	2	....	Arctic & Internal H_2S
		9"—3,000 psi	2	....	Arctic & Internal H_2S
13⅝—10,000 psi	13⅝	7⅛"—3,000 psi	2	147591	Standard & Internal H_2S
		9"—3,000 psi	2	147594	Standard & Internal H_2S
		7⅛"—3,000 psi	2	....	Arctic & Internal H_2S
		9"—3,000 psi	2	....	Arctic & Internal H_2S

TABLE 2—ROTATING STRIPPER RUBBER

Kelly Shape and Size (in.)		Drill Pipe Size (in.)	Largest O.D. Stripper Rubber Expands to Pass (in.)	Minimum Bore of Rubber (in.)	Stripper Rubber 500 PSI Working Pressure Shaffer Type SS-200 Part Number	Type	Stripper Assembly (Less Rubber) Minimum Bore (in.)	Part Number
Hexagon	Square							
....	2½	2⅜, 2⅞ or 3½	6½	2 13/32	147477	RS-2-6 (23-45)	8⅛	147510
3	3							
3½	....							
3½	3½	3½, 4 or 4½	8	2⅞	147481	RS-3-8 (35-66)		
4¼	4¼							
4½	....							
5¼	....							
5¼	5¼	4½, 5 or 5½	8	3⅞	147479	RS-4-8 (45-66)		
5½	5½							
5⅝	....							
6	....							
6	6	5½	8	4⅞	147480	RS-5-8 (55-66)		
6⅝	....							





TYPE 79 ROTATING BOP PARTS LIST

Item Number	Description	Quantity	Standard and H_2S	Arctic and H_2S
1	Quick Release Bonnet Assembly	1	147372	147489
2	Bonnet	1	147373	147492
3	Locking Latch Handle	1	147375	"
4	Cotter Pin	1	050010	"
5	Spring	1	050009	"
6	Locking Pin	1	147374	"
7	Kelly Drive Assembly	1	See "Kelly Drive Assembly" Table	
8	Kelly Drive Bushing	1	See "Kelly Drive Assembly" Table	
9	Dowel Pin	2	050103	"
10	Socket Head Cap Screw	4	010708	"
11	Rotating Assembly	1	147376	147490
12	O-Ring	1	030347	"
13	Rotating Sleeve	1	147380	"
14	O-Ring	1	030149	"
15	Mud Slinger	1	147383	"
16	Hex Head Cap Screw	12	060439	063932
17	Socket Head Set Screw	2	010383	"
18	Top Flange	1	147382	"
19	Check Valve	1	050900	"
20	Pipe Plug—Socket Head, ½" NPT	2	065001	"
21	O-Ring	1	030351	"
22	Oil Seal	2	147386	"
23	Bearing Assembly	1	147384	"
24	Stationary Housing	1	147379	147491
25	Body Seal	1	147389	"
26	Wear Sleeve	1	147381	"
27	Socket Head Cap Screw	24	010988	"
28	Rotating Seal Assembly	1	147500	"
29	O-Ring	2	030386	"
30	Rotating Seal Adapter	1	147504	"
31	Top Adapter Ring	1	147506	"
32	Rotating Seal Ring	5	147505	"
33	Lantern Adapter Ring	1	147502	"
34	Bottom Adapter Ring	1	147501	"
35	Wave Spring	1	147507	"
36	Rotating Seal Gland	1	147503	"
37	O-Ring	1	030822	"
38	Stripper Assembly (Less Rubber)	1	See "Rotating Stripper Assembly" Table	
39	Stripper Rubber	1	See "Rotating Stripper Rubber" Table	
40	Body	1	See "Complete Assembly" Table	
41	Bull Plug—2" LP XXH	2	065798	"
42**	Hydraulic Seal Assembly (Lubricator)	1	147495	"
43**	Manual (Installation, Operation, and Maintenance)	1	147499	"

* Same as for Standard and H_2S.
** Not illustrated.

TABLE 3
ROTATING STRIPPER ASSEMBLY (Less Stripper Rubber)

Description	Quantity	Part Number Holder Bore—8⅛"
Stripper Assembly (Less Rubber)	1	147510
Holder	1	147405
Lock Wire	1	143165
Cap Screw	12	010988
O-Ring	1	030822

Shaffer Type 79 Rotating Blowout Preventers

TABLE 4
KELLY DRIVE ASSEMBLY

Kelly Drive Size (in.)	Assembly Part Number		Bushing Part Number	
	Square	Hexagon	Square	Hexagon
2½	147453	....	147454	....
3	147455	147422	147456	147423
3½	147457	147424	147458	147425
4¼	147459	147426	147460	147427
5¼	147461	147428	147462	147429
5½	147463	....	147464	....
6	....	147430	....	147431

TABLE 5
BELL NIPPLE ADAPTERS

Casing Size O.D. (in.)	Assembly Part Number	Bell Nipple Adapter Plate	Body Seal	Eye Bolt
10¾	147690	147691	147389	050243
13⅜	147692	147693	147389	050243

TABLE 6
STATIONARY PIPE STRIPPER ASSEMBLY

Pipe O.D. (in.)	Stripper Rubber Buna-N SS-201	Type	Assy Less Rubber	Stripper Plate	Cap Screw	Wire	Body Seal	Eye Bolt
2⅜	147477	RS-2-6	147681	147672	010988	143165	147389	050243
2⅞	147477	RS-2-6	147681	147672	010988	143165	147389	050243
3½	147478	RS-3-6	147681	147672	010988	143165	147389	050243
3½	147481	RS-3-8	147681	147672	010988	143165	147389	050243
4	147481	RS-3-8	147681	147672	010988	143165	147389	050243
4½	147479	RS-4-8	147681	147672	010988	143165	147389	050243
5	147479	RS-4-8	147681	147672	010988	143165	147389	050243
5½	147480	RS-5-8	147681	147672	010988	143165	147389	050243
6⅝	150043	RP-1666	147682	147673	010728	143165	None	050243
7	150050	RP-1670	147683	147674	010728	143165	None	050243
7⅝	150057	RP-1676	147684	147675	010729	143165	None	050243
8⅝	150064	RP-1686	147685	147676	010622	143165	None	050243
9⅝	150071	RP-1696	147686	147677	010622	143165	None	050243
10¾	150078	RP-16107	147687	147678	010622	143165	None	050243

TABLE 7
STARTING MANDRELS

Designation	Part Number
2⅜ I.F. (NC 26)	145613
2⅞ I.F. (NC 31)	145614
3½ I.F. (NC 38)	145615
4 I.F. (NC 46)	145616
4½ I.F. (NC 50)	145617
5½ I.F.	145618
3½ F.H.	145619
4 F.H. (NC 40)	145620
4½ F.H.	145621
5½ F.H.	145622
6⅝ F.H.	145623
2⅜ Reg.	145624
2⅞ Reg.	145625
3½ Reg.	145626
4½ Reg.	145627
5½ Reg.	145628
6⅝ Reg.	145629

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Appendix III

Grant Tool Co. rotating drilling heads

GRANT OIL TOOL COMPANY

ROTATING DRILLING HEAD MODELS 7068, 7368, 8068

(PATENTED)

WRITE FOR BULLETIN 86

EQUALLY EFFECTIVE WITH AIR, GAS, OR MUD CIRCULATION MEDIA

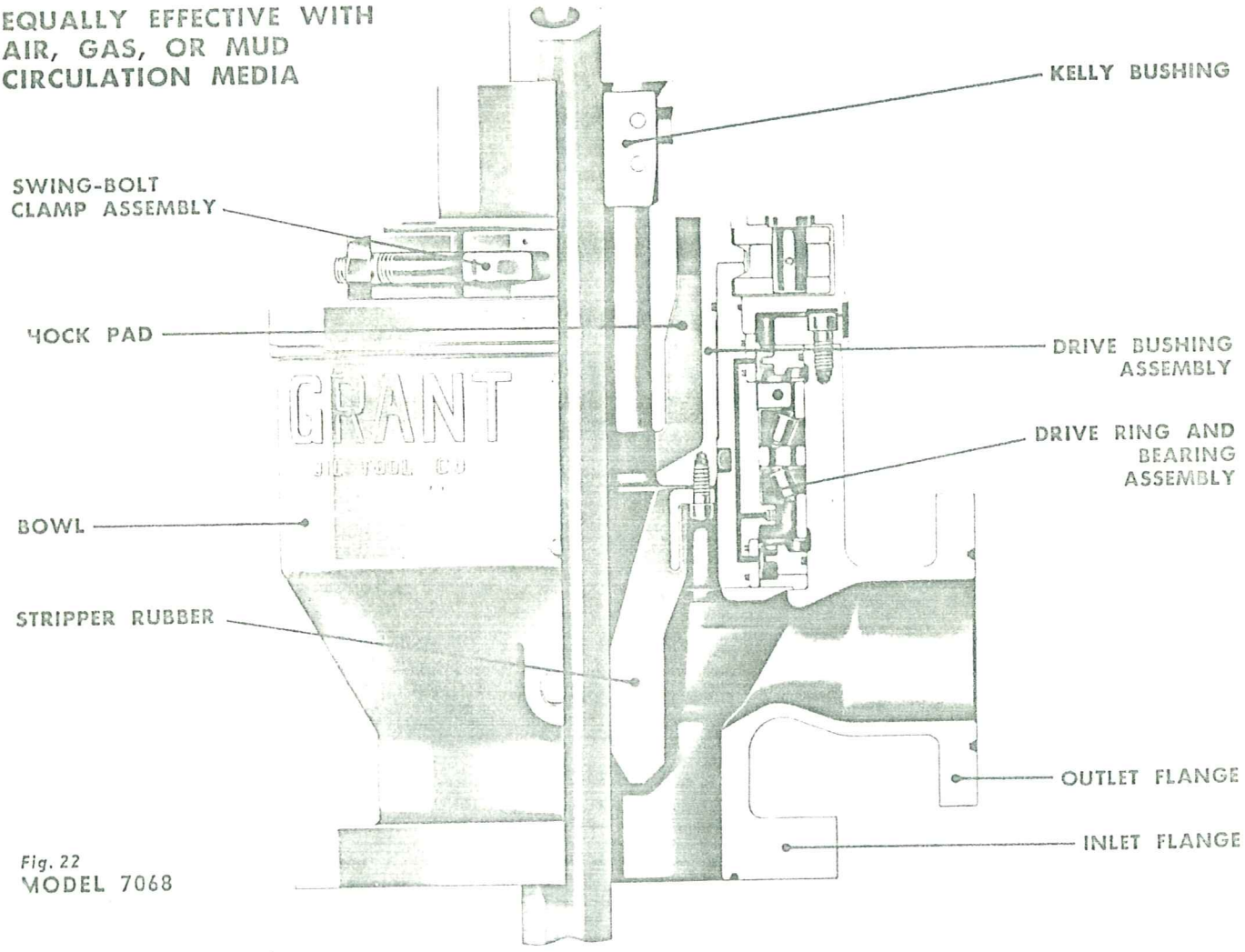


Fig. 22
MODEL 7068

The Grant Rotating Drilling Head has become increasingly popular in all phases and types of drilling operations

When drilling with air the Rotating Head diverts annoying and potentially hazardous dust from the rig floor.

When drilling with fluids, the Rotating Head is extra valuable if the drilling fluids become gaseous, requiring assured control and diversion to maintain the safety of the rig and crew.

The Rotating Drilling Head may be specially adapted for use on geothermal projects to divert steam from the rig floor.

RUGGED CONSTRUCTION—Hundreds of thousands of hours of field experience in all drilling conditions have proved the all-around durability and long range economy of this drilling head design.

EASY HOOK-UP—The Grant drilling head is relatively small and can be easily moved with integral lifting eyes. Provision is made for easy hook-up to customers B.O.P. or other units.

FLEXIBILITY IN STRIPPING—On special order, Grant supplies drive bushings and stripper rubbers to permit stripping string reamers, stabilizers, etc. up to 8¾" through the head. Special stationary casing stripper rubbers permit stripping up to 10¾" casing. There also is a wire line stripper adapter as optional equipment.

CONSTANT LUBRICATION—All moving parts are sealed and operate completely submerged in pressurized oil for long, trouble-free service. Three styles of lubricant accumulators are available: 17 gallon recirculating; 17 gallon non-recirculating; and recirculating plate assembly to fit a customer furnished 55 gallon drum.

AUTOMATIC DISENGAGEMENT—The kelly bushing automatically engages or disengages the drive bushing when the kelly is picked up or run back through the head. A single bolt clamp is loosened to remove the drive bushing when passing the bit through the drilling head bowl.

SHOCK ABSORPTION—Lateral shock loads from the kelly are cushioned by a massive rubber insert. Bonded between the drive bushing's inner and outer sleeves the bushing prevents damage to the head.

GRANT Rotating Drilling Heads Divert Potentially Dangerous Gas, Dust, or Steam Away From Rig Floor

Grant Rotating Heads are essentially strippers which divert anything rising up the annulus safely away from the rig floor. Models are available for blowout preventer stacks from 6" through 20", and for mounting directly to conductor pipe.

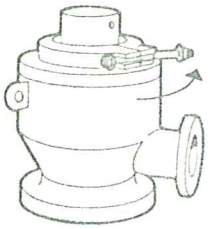
During drilling, tripping in or out, or at static intervals, these units provide a continuous seal-off on the kelly, drill pipe, tool joints, or drill collars. Mud, dust, air, gas, or steam is diverted through a side outlet, thus keeping the crew and floor area safe.

APPLICATIONS

Grant Rotating Heads are ideal for both air/gas or mud drilling using either conventional or reverse circulation. These units have proved successful in all types of drilling environments for more than sixteen years, and have helped broaden the use of air/gas as a circulation medium, controlled pressure, and reverse circulation.

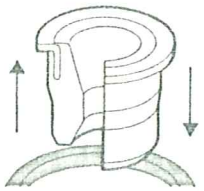
A modified version is available for high-temperature work, and has over six years of successful operation in geothermal wells.

In mud drilling, these heads are especially valuable in diverting gas-cut mud during kicks.

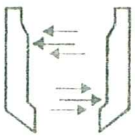


Low Profiles—the entire line is compact, with low elevations from 23⅞" to 38".

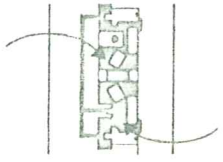
Easy Access to Bore—bushing assembly with attached stripper rubber is removed quickly by unlocking a swing bolt clamp. Assembly is then lifted through the rotary table (10¾" for 6" head, and 17½" for all other models). With assembly removed, anything capable of passing the blowout preventer can pass the head.



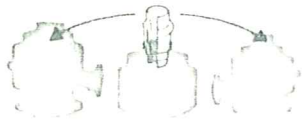
Stripping Convenience—stripper rubber is designed for seal-off on all drill string components. The rubber expands and contracts as the kelly, drill pipe, and tool joints are stripped in or out of the hole. Stands of drill pipe may be added or removed during tripping without loss of time since the drive bushing assembly is removed only for drill bits or special tools. Optional stripper rubbers are available for wireline, or for large-diameter elements such as reamers, stabilizers, and casing (to 10¾").



Shock Absorption—a massive rubber insert, bonded between the drive bushing's inner and outer sleeves, cushions lateral shock loads. The deep length of this insert provides a wide spacing between the major load areas to dampen kelly "whip" and protect the rotating mechanism.



Pressurized Lubrication—all moving parts are sealed from foreign matter and completely submerged in a bath of pressurized oil for long, trouble-free service. Grant offers lubricant accumulator systems of varied capacities in both circulating and non-circulating types. These furnish a continuous source of fresh, pressurized, filtered oil to bearings and seals.



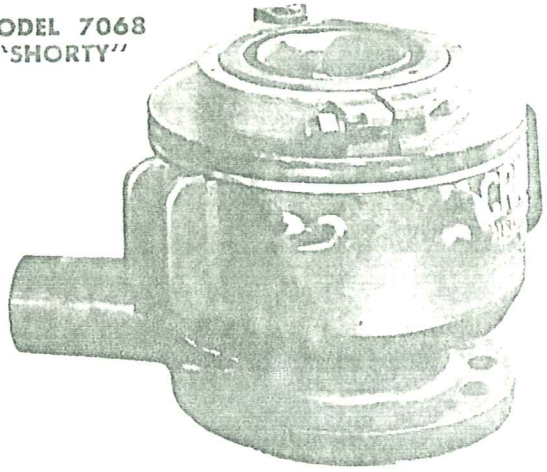
Easy Field Maintenance—all parts are replaceable, and most are interchangeable between models. The drive bushing assembly, for instance, is interchangeable in all but one model. Stripper rubbers can be replaced in minutes and require handling only eight capscrews.

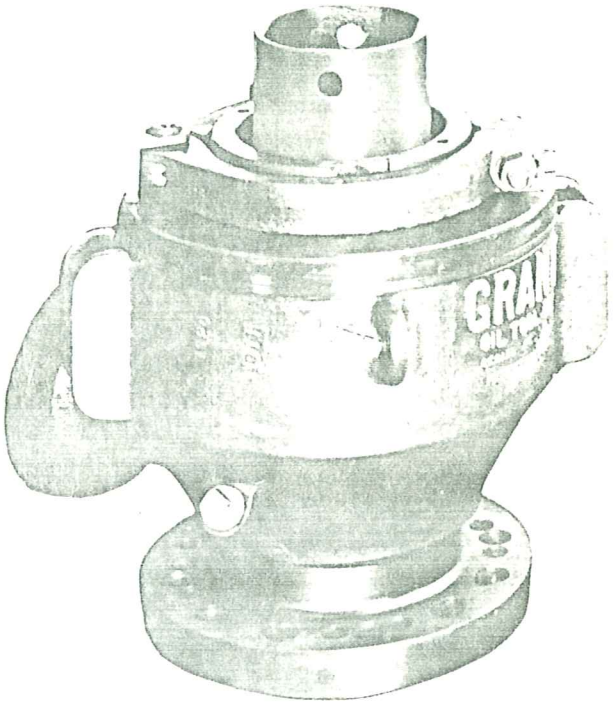
GRANT OIL TOOL COMPANY

ROTATING DRILLING HEAD
MODELS 7068, 7368

WRITE FOR BULLETIN 86 (PATENTED)

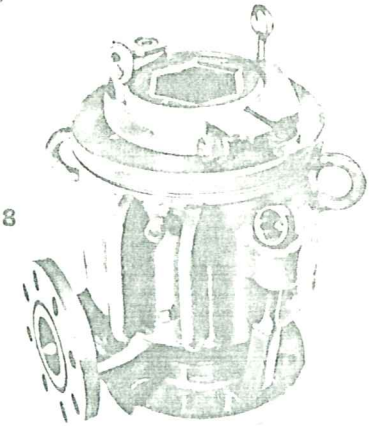
MODEL 7068 "SHORTY"





MODEL 7068

MODEL 7368



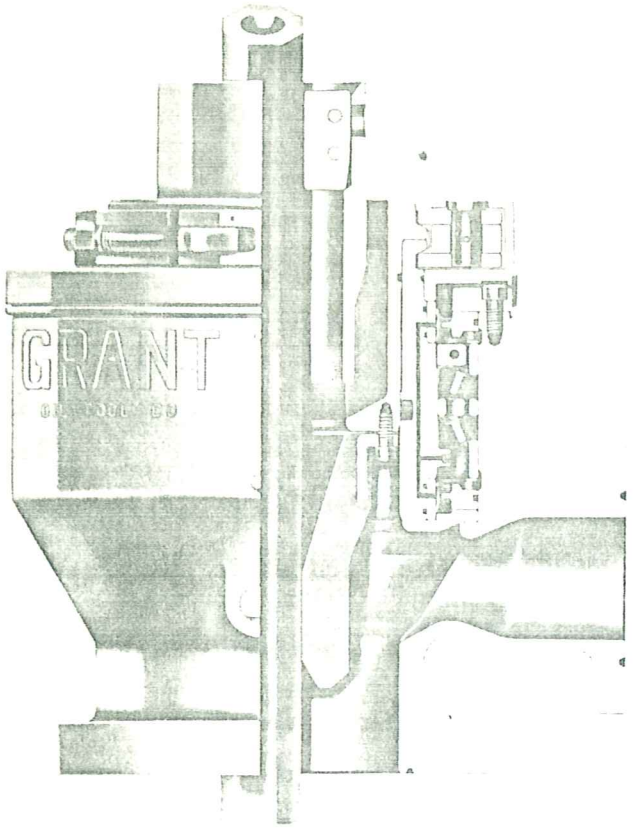
WHEN ORDERING, SPECIFY:

1. Model; 2. Lower flange size; 3. Kelly size and shape; 4. Drill pipe size; 5. High temperature model, if desired.

Fig. 23

TABLE 7—DRILLING HEAD SPECIFICATIONS—MODELS 7068, 7368

			DIMENSIONS: IN. *(MM)*			
Model	Size	Lower Flange	Bore	Outlet	Height	Height
7068	10"	10" 3000/5000# Combination	11¼" *(286)*	6" 2000# Flange	36" W/Standard Drive Bushing *(914)*	29⅞" W/Short Drive Bushing *(759)*
	10" Shorty	10" 3000/5000# Combination	11¾" *(299)*	7" Threaded (male)	—	24⅜" W/Short Drive Bushing *(619)*
	11"	11" 10,000#	11" *(279)*	6" 2000# Flange	36" W/Standard Drive Bushing *(914)*	29⅞" W/Short Drive Bushing *(759)*
	12"	12" 3000#	14" *(355)*	6" 2000# Flange	36" W/Standard Drive Bushing *(914)*	29⅞" W/Short Drive Bushing *(759)*
	13⅝"	13⅝" 5000#	13⅝" *(346)*	8" 2000# Flange	38" W/Standard Drive Bushing *(965)*	31⅞" W/Short Drive Bushing *(810)*
	13⅝"	13⅝" 10,000#	13⅝" *(346)*	8" 2000# Flange	41⅝" W/Standard Drive Bushing *(1057)*	35½" W/Short Drive Bushing *(902)*
7368	6"	6" 2000/3000/5000# Combination	7⅛" *(179)*	4" 2000/3000# Combination Flange	—	23⅞" *(606)*
	6"	6" 2000/3000/5000# Combination	7⅛" *(179)*	7" Threaded (male)	—	23⅞" *(606)*



HEAD OF THE FAMILY

How Grant Oil Tool Company developed a line of Rotating Drilling Heads.

MORE THAN 16 YEARS AGO, Grant engineering and field personnel became aware of a critical need in our industry — the need for a compact, easily maintained rotary head to seal off and divert potentially hazardous dust and gas from the rig floor.

Because this hazard was a major problem, especially when using air or gas as a circulating medium, Grant began the design and manufacture of their first rotating drilling heads. Based on firsthand field reports, the most popular flange sizes and height limitations were considered and incorporated in early models.

After Grant perfected and simplified the basic design, popularity of the head increased. This increase in demand was due not only to the industry's awareness of the unique features of the Grant Head but also to its acceptance for use in mud drilling. The head proved a successful tool in diverting gaseous mud when wells kicked — an important safety feature. Also, the rotating head became useful to drilling specialists when their plans called for drilling with an unbalanced mud program.

Geothermal Drilling

Working closely with operators in geothermal exploration, the internal parts of the head were later adapted to withstand the higher temperatures encountered. Today, few steam wells are drilled in the free world without a Grant Rotating Head on the stack to protect rig personnel.

During this time, Grant was not only improving the head design but was also expanding the line to meet users' demands. Following the standard Model 7068 head, the Model 7068-S "Shorty" head was introduced. The Shorty has a compact height of only 24⅜-in. for use where space is limited under the rig floor.

Large Diameter Heads

The Model 8068 (Split Type) rotating head was added to the family for larger diameter holes, both on and offshore. Consisting of the rotating head body and either a spool or a conductor-pipe mounting flange, the Model 8068 offers versatility of mounting.

Spools are manufactured with a recess up, to accept the drilling head body, and a flanged connection down, to mate with the customer's BOP. Conductor pipe mounting flanges are available in varying sizes, depending on the customer's pipe size. The mounting flange, recessed on the top to accept the body, is welded to the customer's conductor pipe. For offshore use when it is necessary to run a mud line suspension system, a special conductor pipe mounting flange with an adapter ring may be welded to the 30-in. conductor pipe. Removing the adaptor ring exposes an opening of 28-3/32-in. The internal parts of the Models 7068, 7068-S and 8068 are all interchangeable.

For workover jobs and slim holes, a smaller head was needed. In response to this, Grant now manufactures the compact Model 7368 "Six Inch" rotating head. The 7368 has a 6-in. 2000/3000/5000# combination lower flange, 7-1/16-in. bore and an overall height of only 23⅞-in.

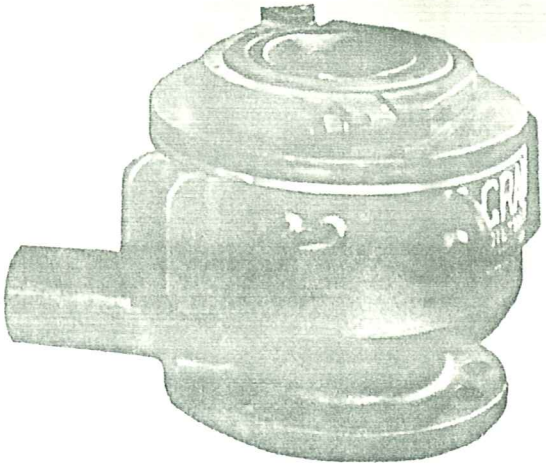
High-Pressure Head

The latest addition to the family of drilling heads is the Model 7370, high-pressure head. Still in the R&D stage, this head has been shop tested to 2000 psi while rotating and field tested on geothermal wells under the most adverse conditions such as rotating and stripping in and out of the hole with back pressures up to and including 1400 psi.

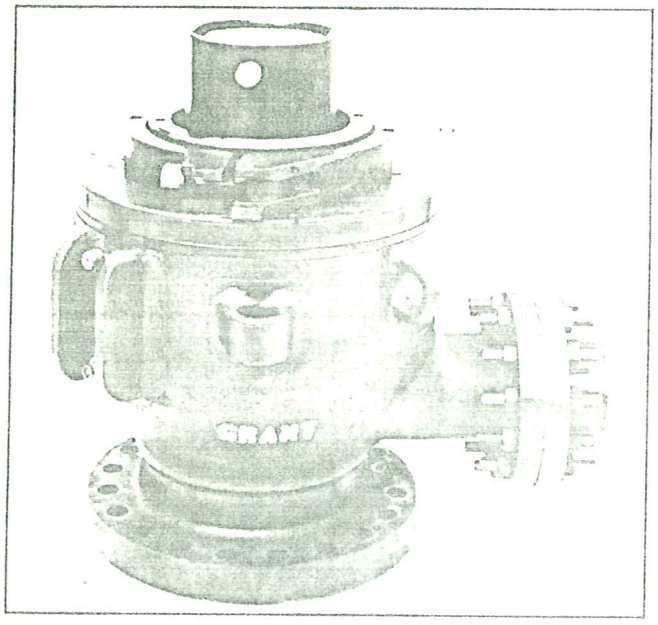
Another design, a low-friction offshore rotating drilling head is now being field tested and will likely be the next member of the family. Unlike other Grant heads, the offshore model has a built-in oil reservoir and pump which eliminates the need for connecting and disconnecting accumulator (oiler) hoses. It also has a feature that allows remote clamping and releasing of the body to the base. Operated from the rig floor, it will save valuable time when tripping and eliminate the need for rig personnel to crawl under the floor to connect or disconnect the body from the mounting base.

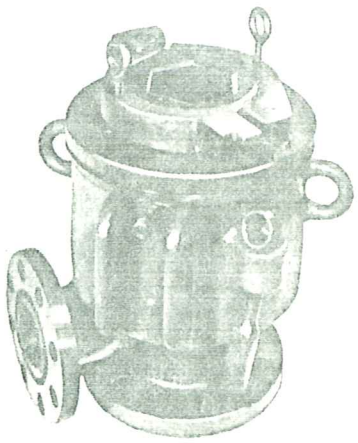
Other models of rotating heads and further improvements of existing models are continually being studied today — 16 years after the first Grant head was introduced.

Wait till you see the Grant family 16 years from now!



Understanding Rotating Drilling Heads





SEVERAL MISUNDERSTANDINGS persist about rotating drilling heads — what they can do, and what they really can't be expected to do. As specialists in designing, manufacturing and improving the breed for over 19 years, Grant Oil Tool engineers have a great deal of first hand feedback from actual field experience. Here's what they say.

First of all, some people still mistakenly call the drilling head a "rotating blow-out preventer". Actually, while today's heads are greatly improved over early models, they really are *diverters*. In fact, often the best installation is on top of the BOP!

Used to seal the string — continuously — the drilling head provides a safety system by diverting gas, mud, dust, dirt or steam away from the rig floor. It seals when drilling, tripping, or just circulating. Grant models can strip casing or tubing and, with special adapters, even a wire line stripper can be attached to provide constant, sealed protection.

Used with all types of drilling, the benefits of a drilling head vary with the type. In air or geothermal drilling, for example, the air, dust or steam is sealed and diverted to protect crew and equipment. In mud drilling, the rotating drilling head can provide better overall well control and can make major savings in mud costs.

When installed with a BOP (ram type or annular), the drilling head helps maintain control and rotation when gas kicks occur by giving the driller a way to keep control without closing the BOP.

Another area of confusion about drilling heads is their pressure ratings. Actually, any attempt to pressure rate a drilling head, whether made by Grant or any other manufacturer, is complicated by several elements. Even though all components are designed and manufactured to meet specifications, the overall pressure rating is dependent upon actual field conditions such as stack alignment, condition of the stripper rubber, condition of the kelly and other external factors.

Because there is such a wide range of applications and well sizes, Grant has developed a full line of rotating drilling heads over the years and is presently working on additional sizes and models as well as advanced designs for future improvements.

Presently, the standard model 7068 and compact "Shorty" 7068-S heads are in wide use. The model 8068 split type is used for larger diameter holes, both on and offshore, with a wide versatility of mounting. In addition, for workover and slim hole jobs a smaller head, the model 7368 "Six Inch" head, is offered.

Circle 8