The Flexite Pumping And Its Application To Deep Well Pumping

By L. E. Johnson
Harbison-Fischer Manufacturing Co.
Fort Worth, Texas

The materials and the workmanship for the present day oil well requirements have changed greatly from those used 20 to 30 years ago. Both the materials and the workmanship have been improved to meet the requirements presented to us in deep well pumping.

The first plunger pump used many centuries ago employed the same mechanical and hydraulic functions of our present deep well pumps.

The first methods used to lift oil employed the use of a common barrel type pump fitted with plunger and standing valves equipped with leather cups (see Fig. 1) similar to those we use today. These leather cup fitted plungers did a good job until wells were drilled to deeper depths and then the cups failed and "turned back" due to greater pressure and abrasion. A substitute for the leather cups was needed and after many materials were tried the composition valve cup we are using today was found to be the answer for some of their problems as these cups would stand more pressure and abrasion than the leather cups.

Many operators were drilling a sand formation and the composition cups were not lasting long enough in this severe abrasion, therefore, the industry continued to search for a pump to handle sand. The manufacturers of cups then designed the "bow spring cup." (Fig. 1) and this cup was a great improvement as this string on the lip of the cup wiped the sand away and lengthened the life of the cups. Another method used to pump sand wells was the "repack" type plunger. This repack consisted of a hemp valve stem packing wound around a plunger body. Some of the later repacks employed the use of a spring to keep the repack tight against the inside of the barrel tube. This also did a good job in shallow wells. And still another type plunger was added to the list of existing plungers to pump sandy wells, and this type is known as the composition ring type plunger. (Fig. 1) This composition ring is made up of several layers of fiber and rubber. This type ring is not to be confused with the flexite ring, as the composition ring and its usefulness is dependent upon the characteristic of expansion and absorption of moisture which gives it a swelling action and, therefore, the fit of this type plunger cannot be controlled. This type ring plunger did a fine job in shallow wells handling sand.

The composition ring plunger was affected by high temperatures and was not the answer to every operator's problem. While the industry was trying to solve their pumping problems they were drilling deeper wells and adding subsurface pumping problems to these they had previously encountered. They were amazed to find that the cups, repacks, and composition rings they had used in the shallow wells would not pump the deeper wells with the same economical efficiency they had anticipated.

The metal to metal pumps were then being tried with great success and for a short time the industry had almost found the answer to their pumping problems. Then the deep wells came in and for a short time these wells passed the depth for economical sucker rod pumping and in came the electric and hydraulic pumps. Manufacturers of sucker rods began a serious study of metals and now rods were made to pump deep wells and pumping units became popular and the manufacturers of subsurface pumps got to work and improved materials and workmanship and the result is the fine precision metal to metal pumps we have today. But again the industry was confronted with another problem and a big problem in deep well pumping. This problem was heat or high bottom hole temp as we most commonly refer to.

The fine precision metal to metal pumps we had were sticking and wearing out too soon and in many cases they would not work at all. Again we tried many different metals and materials. Looser tolerances were tried but all of them without too much success. Loose fitted pumps worked in some cases but when installed in slowing moving hydraulic units the effeciency was too low to lift the fluid to the surface.

Something new was needed but what was this something going to be? The industry needed something to resist high temperature, corrosion, water, oils, acids and mud. The material must be hard enough to wear for a long period of time, it must not swell or change shape, it must be hard but not brittle. The something was conceived to be a ring similar to a compression ring. Now the problem was to find a material or metal to make the ring. Many metals and materials were tried without success until finally a material made up from a vegetable fiber and a proper phenolic composition of which was impregnated with a graphite type lubricant was designed and met the above mentioned requirements.

The material is similar in appearance to a sheet of ply wood in that it has many layers of vegetable fiber separated by the proper phenolic and pressed under extreme pressure to the required thickness.

The flexite ring is made from this material which has the lowest moisture absorption point of any known commercial material available. The ring is a precision ground and manufactured product which will fit the barrel tube and is not affected by swelling action.

The first flexite rings were made up with an angle cut and without the flange. These rings did a fine job in

wells where heat was a problem but the desire for perfection was keeping the company working on new designs as we found the rings could and did break and they would come out of the grooves in some wells that had abrasion and other foreign materials. The present ring (Fig. 2) was then designed after many trials and tests to improve the performance. Please remember at this stage there had not been made any flexite rings but the narrow type which is illustrated. This type ring was very popular and is still being used through out the entire oil producing areas. This ring is generally used in fields where large quantities of water are to be handled.

You will agree that many minds were at work trying to improve the material then available for pumping wells. It was a race for superior material, Workmanship, and ideas. The results: Better materials, longer pump runs, more oil lifted for less money. This race is still going on today, and you, the operators, have benefitted from this keen competition. The consolidation of ideas and the desire to keep everything within the A. P. I. specifications has saved much time and money.

Now that you have had recalled to your attention and have had illustrated some of the first types of pumping equipment used since the beginning of the oil industry I would like to talk to you on the subject of the flexite ring, and its application to deep well pumping. But first I want to tell you something about the flexite ring—how it works where it can be used and where it should not be used.

The flexite ring and the spacer are made to slip over a plunger tube. When the end fittings on the plunger tube are tightened, the spaces are tight fitted together and allow the flexite to "float" without being affected by the pressure on the end fittings.

The Flexite Plunger

The sealing action of the flexite ring plunger is obtained by the built-in inner tension of step-cut rings which causes the rings to expand against the smooth wall of the barrel. Under pressure of the fluid load the rings are further forced out against the barrel assuring a perfect seal. Upon reversal of the plunger stroke, the rings take up and release the load gradually. This eliminates sudden shock and reduces stresses on the pump and the sucker rod string. Flexite rings are precision ground for exact fit in the barrel and will not swell, disintegrate or corrode. Rings are made of a hard and tough plastic composition impregnated with graphite to resist wear, reduce friction and to provide their own lubricated in wells making a high percentage of water. The ring is designed to allow it to take up and compensate for its own wear. When the fluid enters the plunger it travels in and out of the first ring to the second ring and so on to the lower rings. This method not only affords lubrication to the rings and barrel tube but it allows each ring to make its own seal against the barrel tube.

Flexite rings operate in barrel tubes that are base size to plus .005 with the same efficiency. As they are precision ground under tension and they secure their seal by the pressure exerted within the ring itself this feature gives a long life to both the ring and the barrel tube. The flange on the ring keeps them locked in place in the spacers and prevents them from breaking and working out of their spacers or grooves. This feature allows you to run plungers in common barrels or tubing pumps without losing the rings in the event the plunger strokes out of the barrel several times before the plunger is properly spaced. This interlocking design also permits rod breaks to be repaired without coming out to redress the plunger due to rings getting out of grooves.

The flexite plunger can be used in most of your present pumps provided they do not have liners that are misaligned. They can be used in wind mill pumps, water well pumps, insert pumps, dual zone pumps, deep well pumps, common barrels, tubing pumps, and also in oil line or boiler feed reciprocating pumps. The barrel or liner that you use must be smooth and without deep scores. It can be worn .005 and still be used provid-

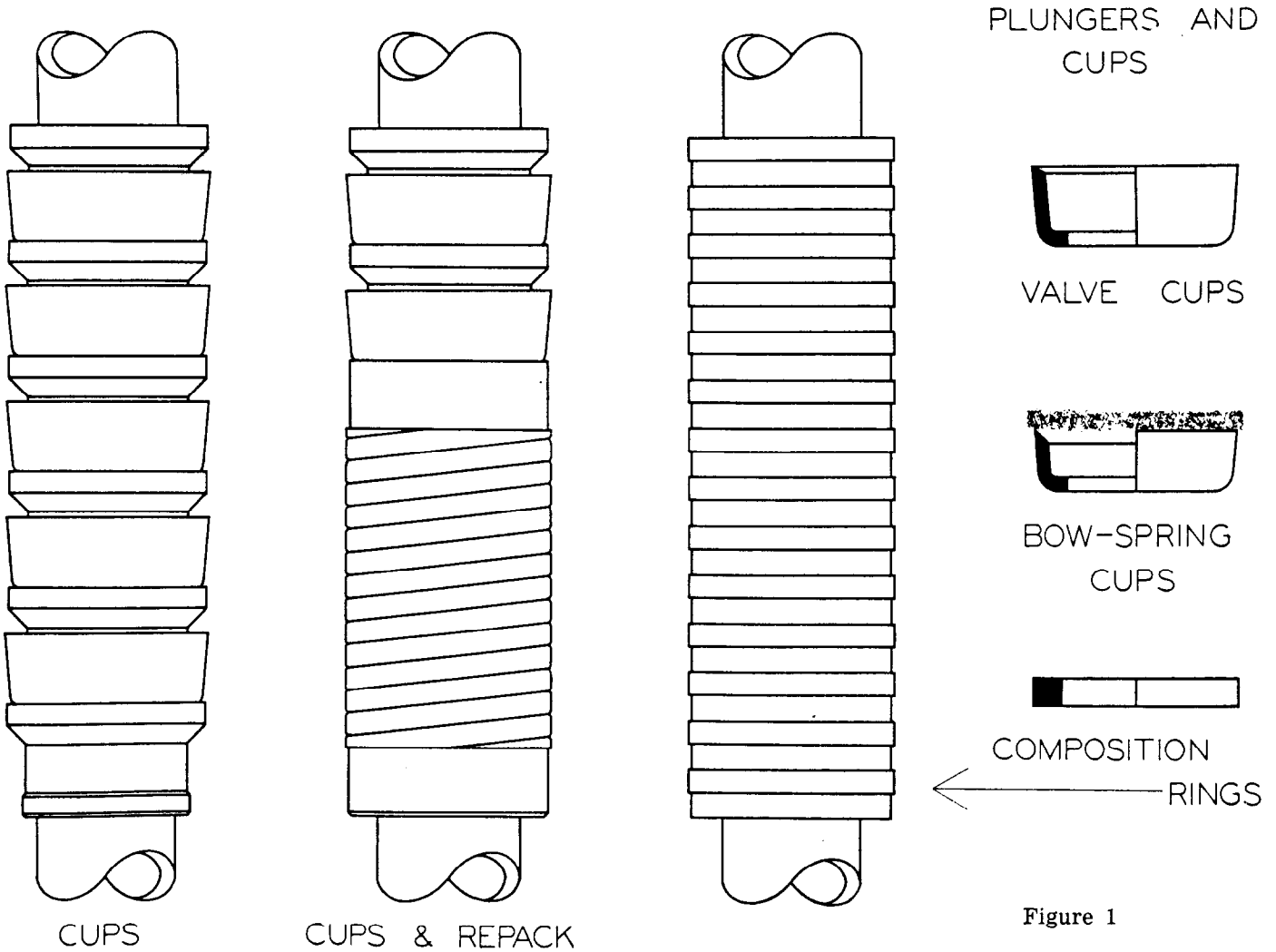

Figure 1

ing the wear is generally distributed throughout the entire length of the barrel tube.

The flexite ring should not be allowed to stroke in and out of the barrel tube. In the event a stroke thru type pump is needed to keep down scale or gyp deposits we install a solid flexite plunger guide on each end of the pump plunger and by regulating the length of the stroke through nipples on the end of the barrel tube you can stroke the plunger out of the tube and the flexite guides will stroke out and leave the flexite rings inside the barrel tube.

We do not recommend the flexite ring be used in wells that have a fine floating sand as it will cut the rings out very fast. However, we do have many operators that use the flexite ring in Yates and Queen sand wells, but they are moving a lot of fluid and this fluid keeps the sand moving and prevents it from cutting the ring out. Having a lot of fluid is very important to the long life of flexite ring in sand wells. Many operators use the flexite ring in their pumps immediately after a sand frac job and they do a good job for many of them as they do not stick. Some operators find it cheaper to run flexite rings behind frac jobs even though they use "several sets of rings they can clean the well up and then run a pump more suitable to the well condition.

Wells and sand frac jobs all present a different problem to the operator and it is for this reason that none of us are able to give the operator one pump or plunger that would take care of all of his different well conditions. In the event you are having some trouble with your present well condition you might want to try a flexite ring plunger and see for yourself just how this ring would operate in your particular well condition.

When using the narrow type flexite ring we recommend that you use 10 rings per 1,000 feet of depth but experience has shown that several more rings has added years to the length of run these plungers make.

We recommend the narrow ring to depths of 6,000' and less. In deep wells we recommend the use of the wide design ring, which has 3 times the contact surface of the narrow ring. We are now pumping wells in excess of 10,000 ft. and can go deeper, if necessary. In deep well plungers we recommend the use of the solid flexite plunger guides on both ends of the plunger and one in the center to stabilize the long tubes and keep them properly centered.

Selecting The Fit of Wide Design Flexite Rings For Deep Well Pumping

To obtain the best performance with the use of the wide design flexite ring plungers, consideration must be given both the number of rings used on the plunger assembly and the actual inside diameter of the barrel in which it is to be run. In the same barrel as the shorter length plungers use rings that are in effect slightly oversize or tighter to maintain seal, and if more of these same rings are used on longer plungers, the tightness or frictional load would be great enough to affect the "free falling" action of the plunger; likewise, as the actual bore of the barrels vary from a plus .006 to minus .002 above and below the nominal size, this tightness would vary from a plunger that was too tight to one that was too loose. Therefore, wide design rings are available in 3 ranges of fits to balance these conditions as shown below.

Example

No. 195E3—1 1/2" wide design Flexite Rings Type "B" for 30 ring plunger for plain barrel tubes.

Type A: For 10 through 25 rings plungers in plain barrel tubes.

Type B: For 10 through 25 rings plungers in chrome plated barrels or 30 ring through 50 ring plungers in plain barrels.

Type C: For 30 ring through 50 ring plungers in chrome plated barrels.

The above rings are being used in deep wells where high temperatures are being encountered; in wells that flow off and stick metal to metal pumps; in dual zone pumps we have

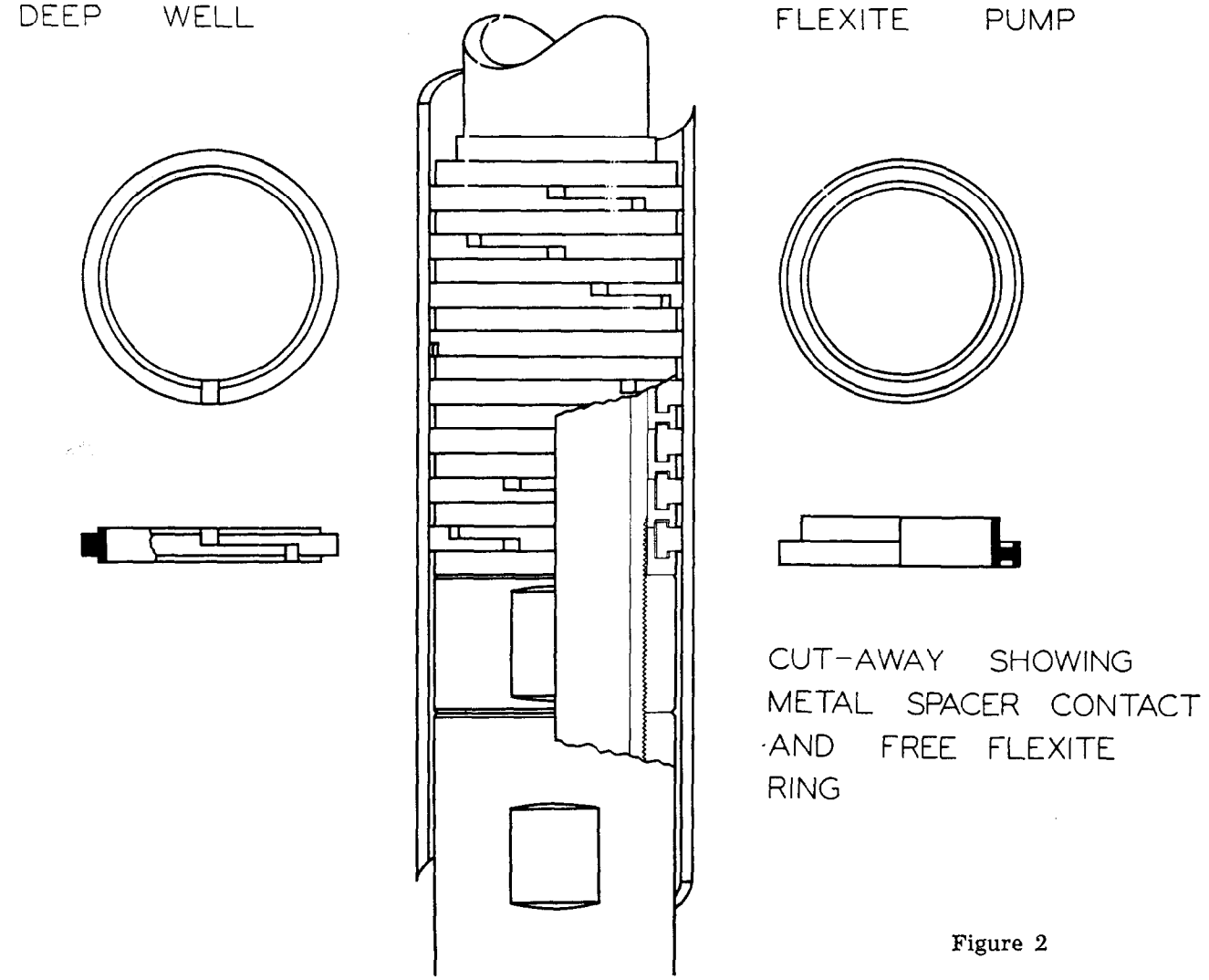

Figure 2

actually increased the production lifted to surface by eliminating the slow dropping action of metal to metal pumps due to heat or other causes. In wells that are shut down for long periods and then started up many metal plungers are stuck and the pump has to be pulled but flexite does not stick and thereby eliminates this problem.

In some sections of the country we find extreme heat in pumping wells and when the bleeder valve is opened on the well head steam will be forced out under considerable pressure. Under such extreme conditions as these a lot of trouble was encountered with all pumps and our regular flexite material was not sufficient to handle this 247 degree temperature. A mineral fiber was developed and when combined with the proper phenolic our flexite ring was able to withstand this extreme temperature. This success was due to the mineral fiber not being affected by the heat, and these troublesome wells are now being pumped at greatly reduced costs.

Long stroke hydraulic units are now pumping wells 10,000' and deeper, therefore, it became necesssary for the industry to design a pump to operate on units that travelled up to 30' strokes.

As you all know these pumps operating under hydraulic units had to be long and transportation of these pumps to and from the location was a problem, therefore, a transportable deep well pump was most desirable due to the speed in which it could be delivered to location and also it was more economical as the pump could be delivered on a car or pickup and without the use of special equipment. We had a problem to overcome when designing a deep well pump to use our wide design flexite ring plunger. As I mentioned earlier, the ring should not be allowed to stroke in and out of a barrel tube and this eliminated the most common practice of installing a short nipple between two barrel tubes to obtain the desired length of pump.

Our company designed a heavy duty barrel tube connection that permits both barrel tubes to be screwed and marked for honing. After the tube is honed and finished it is then fitted with a wide design flexite plunger and checks out for proper tightness. The pump is then dismanteled in the center section. This method allows for a fast assembly in the field and without a lot of special tools.

The pull rod on the above deep well transportable pumps was also made in 2 sections with a connection in the center of the rod. As 26' stroke hydraulic units need at least 33'-6" pull rods we found it necesssary to make the pull rod in two sections.

These pumps have been in operation for the past 18 months in Andrews County pumping wells at a depth of approximately 9,500' (Wolfcamp formation) and they are operating without sticking. Some of these pumps are lifting large quantities of water and have not been pulled to date for a pump failure.

In areas where large amounts of salt is to be handled under hydraulic long stroke units it will be necessary to use a barrel tube that will resist salt water corrosion, some of them may be chrome plated for hardness, and the fittings and spacers on the flexite ring plunger should be made of stainless steel.

Many combinations of materials are available for your well condition, therefore, it is of considerable importance that anyone making a recommendation for a pump to handle your problems be given all of the information possible on this particular well.

Please let me remind you that the flexite ring plunger was not designed to meet every well condition. I have tried to outline some problems in which this ring will surpass the performance of any known metal plunger. I do not want you to interpret this discussion as a complete solution to your well problems. Your well condition may not fall within the category in which you could apply the flexite ring and receive the results you expect.