TOWARD A DEPENDABLE HAND PUMP

By

Wilbur E. Palmer
Sanitarian Advisor

Health Division

U. S. Technical Cooperation Mission to India

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In many years of rural India the villager will continue to depend upon wells as a source of water supply for a long time to come. The installation of diesel, petrol or electrically powered pumps will be delayed in many areas due to lack of (1) finance at the village level for the maintenance and operation of installations even in cases where the entire cost of the installation is borne by the State or Central Government and (2) adequately trained personnel required to supervise the maintenance and operation of the installation.

With the above in mind it is evident that a properly constructed well that has one or more hand pumps properly installed will be needed for many years to insure the villagers a safe water supply at a low installation and maintenance cost. This low overall installation and maintenance cost makes the hand pump an ideal installation for villages, melas, fairs, private homes and schools which do not have access to safe piped water supply. The effectiveness of the hand pump has been demonstrated in many areas of India. There have been successes in Bihar, in West Bengal, in the Indian Council of Medical Research project in Bihar, and in the Barapali Village Service in Orissa.

Pumps available in India have been and are being greatly improved to make them rugged and capable of withstanding much abuse and still remain operable. At the same time maintenance operations are simplified by recent designs. Engineers working on rural water sup-

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plies have made suggestions which make the hand pump more dependable in providing safe water for the villages. Hand pump manufacturers in India have shown a great interest in design improvements and have cooperated in the development of a more dependable hand pump. This paper reports observations and recommendations made in regard to hand pump installation. India experience shows that the following points should receive careful consideration:-

Choice of Hand Pump

1. The pump or pumps selected should be manufactured in India in needed quantity by a reliable company or companies.
2. The original cost should be low and the pump made of material strong enough to withstand maximum use and abuse by the villagers.
3. Repair parts should be available at low cost and adequate stocks of these needed parts maintained by the manufacturers at all times.
4. The pump base should be so constructed that a water tight seal may be easily maintained between the well platform and pump base at all times. It should also be recessed so as to permit a 4-inch pipe to be inserted at least one inch into the pump base. If the 4-inch pipe is extended at least one inch above the cement platform and such a recessed pump base is installed, contaminated surface water will be prevented from entering the well.
5. Standard size nuts and bolts (1/2-inch) should be used throughout. This permits the stocking of a minimum number of nuts and bolts and reduces the number of tools needed to make necessary repairs.

6. All parts of the pump where bolts and nuts are used should be constructed in such a way that the bolt heads and nuts are easily accessible to wrenches for installation and removal.

7. All pump rods used should be of standard size (1/2-inch) with standard thread.

Pump Type

Many areas of India have a water table high enough so that a common lift (suction) pump may be used. A pump meeting the general requirements may be purchased in India for approximately Rs. 32. Whenever the water table falls below 20 feet during the dry season it becomes necessary to use a cylinder with the common lift pump head. With the addition of a cylinder the common lift pump head can be used when the water table is located at a depth of 20 feet to 40 feet.

The modifications necessary to adapt the common lift pump to use at a depth of 20-40 feet are as follows:

1. Remove the plunger from the plunger rod.
2. Remove the check valve located in the base of the pump.
3. Install a brass pump cylinder with a check valve at its base. The cylinder, normally 3 inches in diameter, should preferably be installed at or below the water level and in no case should it be located more than 20 feet above the low water level. A 3-inch brass pump cylinder, 9 inches long with check valve, suitable for a 7-inch stroke pump is available in India for Rs. 25.
4. Connect the plunger in the cylinder to the pump rod using 1/2-inch mild steel rod. This rod must be measured and cut so that the plunger works freely in the cylinder at all positions of the pump handle.

5. A check or foot valve (Rs. 10) installed at the end of the pipe extension below the cylinder is desirable. This check or foot valve is in addition to the check valve at the base of the cylinder.

A more rugged pump head, usually available as a lift and force pump should be used when the water table at its lowest level is greater than 40 feet. The same criteria as outlined for the lift pump should be considered when purchasing this type of pump. A modified cylinder (longer, smaller diameter, more rugged check valve) may soon be produced in India for use with this pump for approximately Rs. 45. The cylinder generally used at present costs approximately Rs. 80.

In areas where the depth to the static water level is great (40 to 100 feet) pumping with a force and life hand pump may be made much easier by the use of springs to offset the weight of the plunger and long pump rod. The force and life pump generally used in India has on one occasion been improved by using two coil springs. The springs are slipped over the plunger guide rods so that they work against the casting that is fastened to the pump rod. The coil springs work up and down on the guide rods as the handle is raised and lowered. Wooden pump rods with metal threaded joint fittings can be used in such situations. The wooden rod is buoyant and does not add to the weight to be lifted by the pump. This idea may possibly be in use in India and a record of such use would be of considerable interest.

Plunger

A properly constructed plunger adds greatly to trouble free hand pump operation. Plungers used in most hand pumps are of cast-iron and the plunger valve is constructed with the upper part of the plunger

cage acting as guide for the valve. This type of construction permits the valve to wear on one side and the valve soon begins to leak water. Another disadvantage of the cast iron plunger is the rusting of the parts so that after a few months of use it becomes difficult to separate . the threaded parts for replacement of the buckets without use of a pipe wrench and without breaking the plunger casting. The use of brass for the plunger corrects most of those objections. An improved brass valve casting now in production is made with an extension in the form of a cross which, in the assembled plunger, extends into the valve opening and acts as a guide. No leakage problems have been reported in some 300 installed pumps of this improved design. The bottom of the plunger casting may be constructed with two extending sections which can be of great assistance in loosening the lower sections of the plunger.

Corrosion Problems

Corrosion has been a problem in certain areas in India. In areas near salt water such as the Bay of Bengal and the Arabian Sea, salt in the atmosphere causes corrosion damage. There also is corrosion damage if the water pumped is saline. The use of brass wherever possible reduces the corrosion. Brass may be substituted for cast iron or steel in the following:

1. Cylinders
2. Pump plungers
3. Lining the working barrel of a common lift pump with a sleeve.

Special research work needs to be done on the proper rust inhibiting paints that should be used on the outer surface of the pump.

Pump Buckets

The material generally used for hand pump buckets has been leather. This material has disadvantages which are listed here:

1. Reluctance on the part of a number of people to use water that has come in contact with leather.
2. Variation in the quality of leather available for molding buckets.
3. Short life of poor quality leather buckets.

In addition, the lack of established standards as to dimensions, quality of leather and the diameter of the center opening necessary to properly fasten the bucket into the plunger has been a problem.

Experience has shown that a top quality leather bucket will operate satisfactorily in a hand pump installation. However, to overcome the disadvantages mentioned, research has been done on the use of other materials as a substitute for leather. Polythene had shown promise. When tested in the field it gave good results in certain installations. In areas where the pumping of fine sand was a problem there seemed to be excessive wear. When used with brass cylinders and in areas other than those mentioned above it lasted as long as the better quality leather buckets. The first molds were modified to give more strength at points of wear and another type of polythene was used in the production of the later buckets.

Nylon was used to make a few buckets but this material was discarded due to the restriction on imports. Nylon has shown good results

and should again be considered when this material is available in India. The most satisfactory material used so far has been a rubber composition* developed by the Imperial Chemical Laboratories (ICI), Calcutta. This rubber composition was suggested by the laboratory specialist of ICI and during limited tests has been used satisfactorily under all conditions and in contact with all metals used in pump construction.

Pump Rod

Standardization is desirable and it is suggested standard 1/2-inch pump rod be used in all well installation particularly where water lift may at any time be more than 20 feet. Some engineers have recommended the use of galvanized rod. However, experiences in many areas of India indicate that ordinary 1/2-inch rod as available in the market is satisfactory for this purpose.

Observation of a number of installations indicate that an important point frequently overlooked is the correct length of the pump rod.

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* Rubber composition ingredients:

	Parts by weight.
Smoked Sheet	90.
'Butakon' S-8551	10.
Kosmos 60	60.
Vulcafor HBS	0.65
Vulcatard A	0.5
Nonox BL	1.5
Stearic Acid	2.0
Sulphur	2.75
Zinc Oxide	5.0
Vulcatac CH	6.0
Paraffin Wax	0.75

Cure 20 minutes at 60 pounds steam pressure.

When the pump rod is cut too short the top of the plunger will hit the top of the cylinder with each stroke and damage or breakage of the plunger will result. When a force and lift pump is used, a pump rod that is too short will not permit the packing gland to work as it should. The round part of the special upper section of the rod, which can be considered part of the pump, will drop below the packing gland and when the plunger is lifted at the down stroke of the handle water will spray out around the flat part of this special upper or pump section of the rod. Some installations have substituted a longer cylinder to permit error in the length of the pump rod. This is a very expensive make-shift arrangement and not recommended.

In cases where the pump rod is too long, the plunger will hit the botton of the cylinder when the pump handle is raised and damage to the plunger and to the cylinder check valve will result.

Foot Valve

A foot valve is recommended for use in the installations where a cylinder is required and the water level is more than a short distance (2 feet) below the lower portion of the pump cylinder. In general the cylinder should be located at or below the normal water level. However, in many areas of India the water level drops many feet during the dry season of the year. In this case as a safety factor the suction pipe should extend to a point at least two feet below the lowest expected water level. A foot valve located at the lower end of the suction pipe will make a more trouble free installation. The foot valve acts acts as a safety check so that water

is maintained at the pump spout level at all times. There will be no need for the pump handle to be raised and lowered a number of times before water is actually delivered from the pump spout.

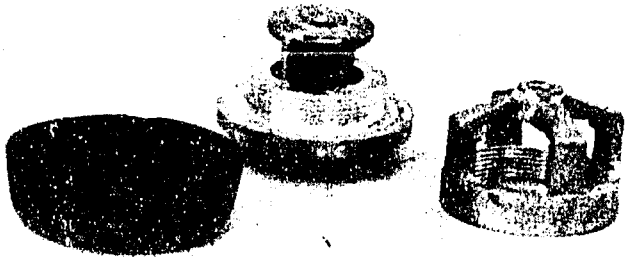
One obvious weakness of foot valve construction has been the breakage of the valve stem itself. This has been corrected by increasing the valve stem diameter. A second cause of failure has been the loosening of the retaining nut which holds the center valve in place. This has been corrected by having the valve stem lengthened so that a cotter pin may be inserted below the tightened retaining nut. Additional research and testing needs to be done in the development of an improved foot valve.

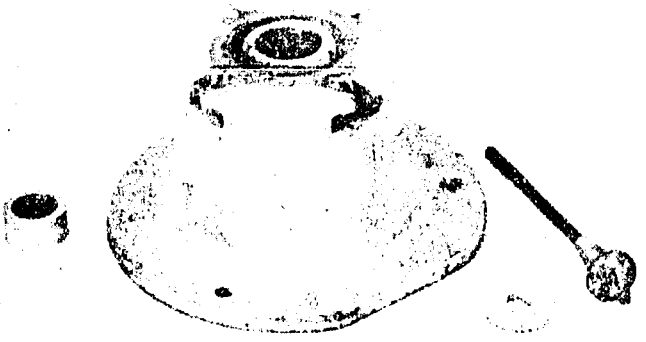
Repair

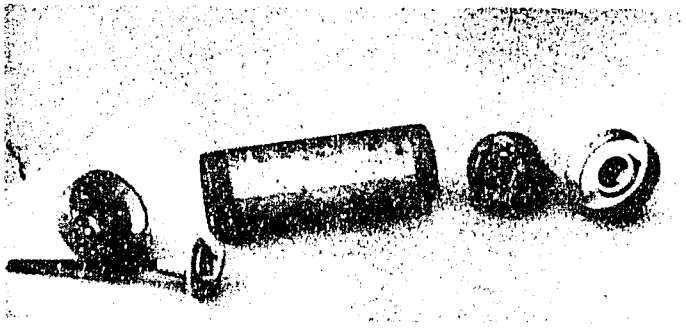
One of the basic problems encountered when installing hand pumps has been that of providing an alternate source of water when the local well has been covered and the single hand pump installed is in need of repair. This problem may be corrected by the installation of two hand pumps on the well. Whenever the diameter of the well is 3 feet or more the above suggestion is practical. In most instances at least one of the pumps will be in operating condition at all times. The second problem is that of repair. The maintenance of a repair crew at the district or at the State level presents problems of staffing, financing travel and large stocks of repair parts. This may be overcome in part by training local blacksmiths or mechanics in simple hand pump repairs. The local Panchayat or a water committee may be made responsible for the maintenance of a stock of

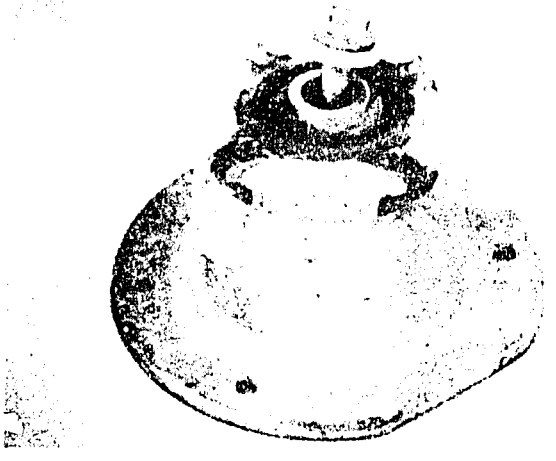
repair parts and tools needed for simple repairs. Funds to purchase the repair parts, tools and funds to pay the repair mechanic may be collected in cash or kind from the villager. For a number of years it will be necessary to maintain a staff at the block level to supervise and assist in major repair problems.

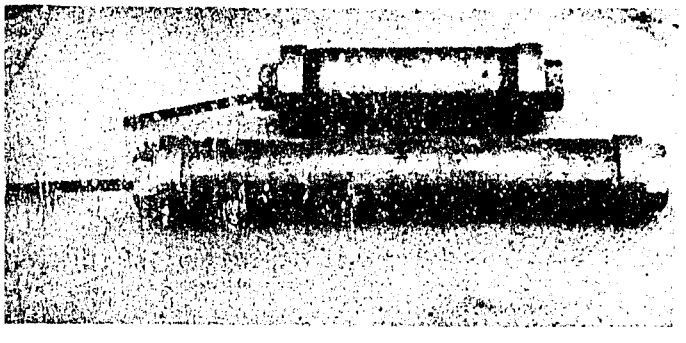
An unbreakable everlasting hand pump is probably too much to hope for. However, efforts in the direction of developing such a pump will pay great dividends in India and cooperative efforts to date have been very encouraging.

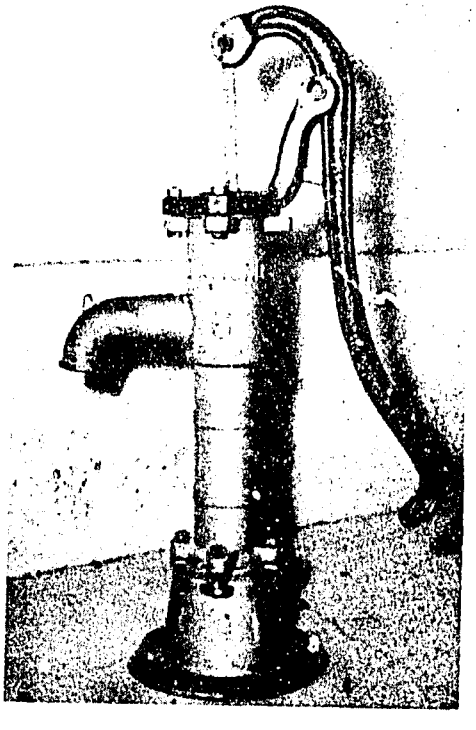


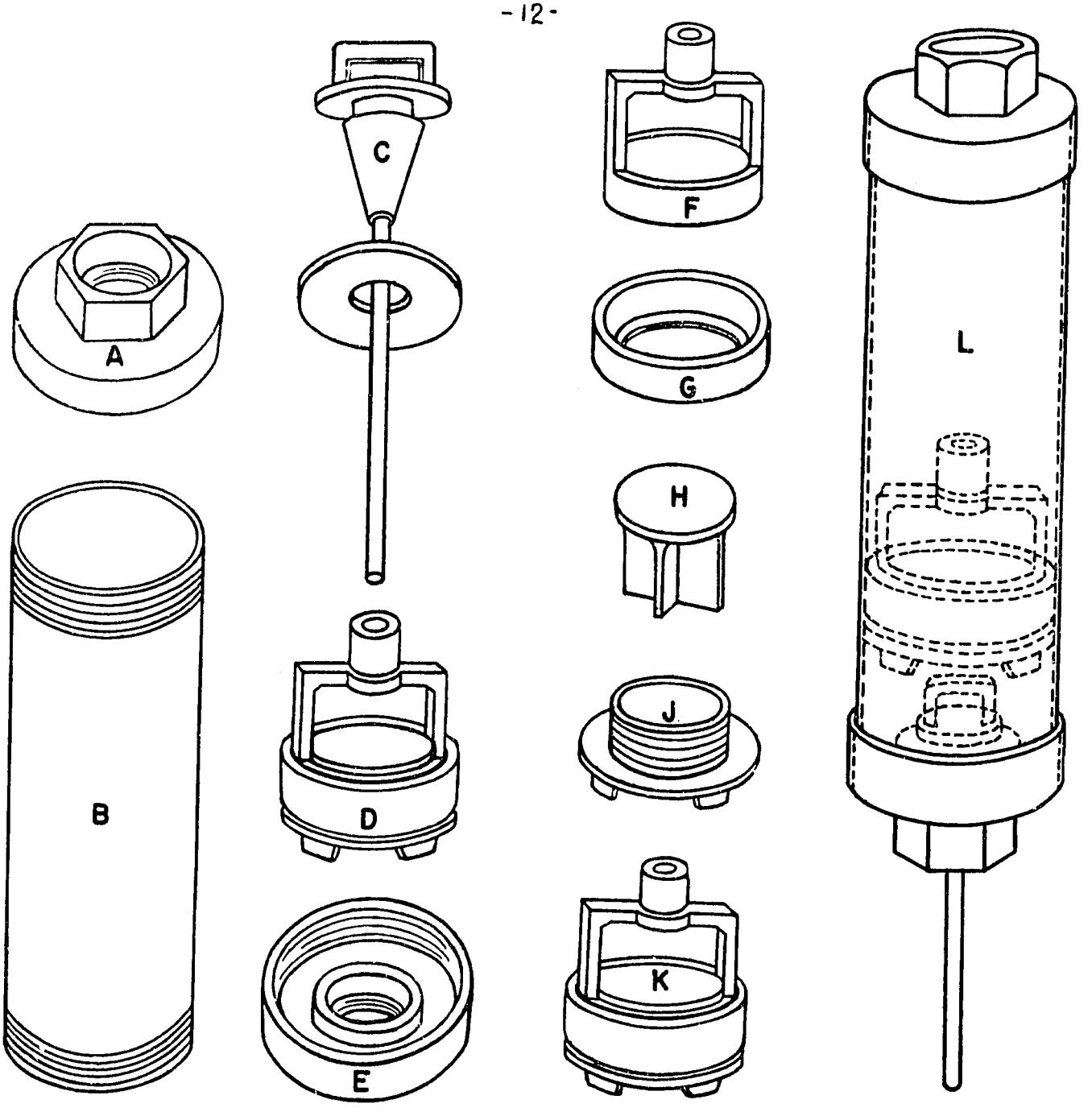












A-E CYLINDER BARREL CAPS

B CYLINDER BARREL

C CYLINDER CHECK VALVE WITH RUBBER WASHER

D PLUNGER & BUCKET ASSEMBLY

F PLUNGER CAGE CAP

G PLUNGER BUCKET

H PLUNGER CENTER VALVE

J PLUNGER CAGE BASE WITH LUGS

K PLUNGER & BUCKET ASSEMBLY

L COMPLETE CYLINDER ASSEMBLY