HANDPUMPS

Introduction

The majority of people in the developing world gain access to groundwater either by means of a bucket and rope, or by using a handpump. Using a bucket and rope can be made easier if the well is provided with a windlass to help to lift the bucket. However, although easy to operate and repair, the bucket and windlass arrangement has serious disadvantages: it does not allow the well to have a cover slab which can be sealed to prevent ingress of polluted water or other contaminants, and the bucket and rope themselves are continually being polluted by mud and dirty hands. Therefore if the water to be raised from a well or borehole is for people to drink, it is preferable to instal a handpump.

Main principle of handpumps

There are many different types of handpump. However, most of them are positive displacement pumps and have reciprocating pistons or plungers. In a piston pump, the piston is fitted with a non-return valve (the piston valve) and slides vertically up and down within a cylinder which is also fitted with a non-return valve (the foot valve). Raising and lowering the handle of the pump causes vertical movement of pump rods which are connected to the piston.

When the piston moves upwards, the piston valve closes and a vacuum is created below it which causes water to be drawn into the cylinder through the foot valve, which opens. Simultaneously, water above the piston, held up by the closed piston valve, is displaced upwards; in a simple suction pump it emerges through the delivery outlet; in a pump with a submerged cylinder it is forced up the rising main.

When the piston moves downwards, the foot valve closes, preventing backflow, and the piston valve opens, allowing the piston to move down through the water in the cylinder.

Range of lift

The ranges over which water can be lifted are grouped in the following categories:

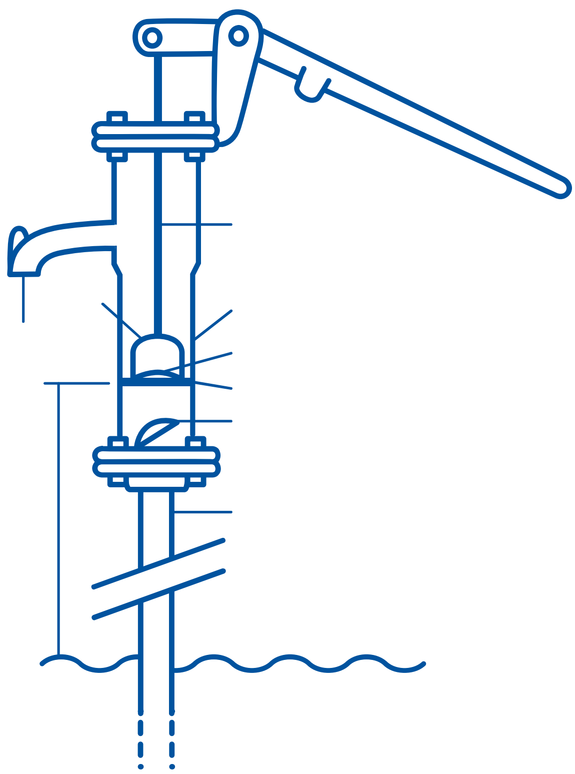
Suction pumps	0 – 7 metres
Low lift pumps	0 – 15 metres
Direct action pumps	0 – 15 metres
Intermediate lift pumps	0 – 25 metres
High lift pumps	0 – 45 metres, or more

Suction pumps

At shallow lifts the cylinder and piston operate by suction and can be housed in the pumpstand above ground. In practice, the maximum suction lift is about seven metres (i.e atmospheric pressure less about 30% system losses due to the ineffectiveness of seals, friction etc) and defines the working range of the suction pump.

Suction pumps have to be primed where seals have dried out or have been replaced; therefore they can be contaminated by dirty priming water. They have a limited range of application, but are the most numerous handpumps in the world, mainly because they are relatively cheap and are suitable for use as a household pump.

The following diagram shows a shallow well suction lift handpump:



Low lift pumps

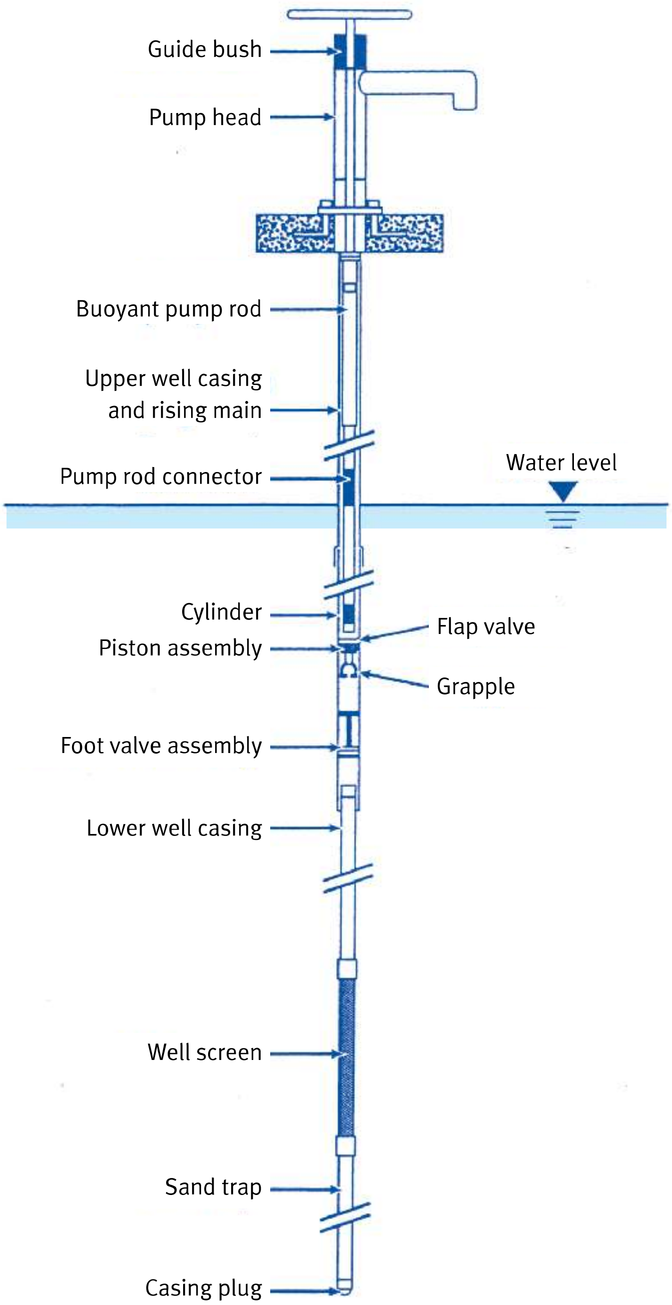
These operate in the range 0–15 metres. With lifts above seven metres, the cylinder and piston have to be located down the well, or borehole, and preferably below water level in order to provide a positive suction head. Theoretically, the lift could be achieved by operating with the cylinder seven metres above the water table but it is usually better to provide a positive suction head, as this assists pumping.

Direct action pumps

In the low lift range some piston handpumps are designed to operate as simple direct action pumps, ie ones which operate without the help of leverage, linkages and bearings. Direct action pumps depend upon the strength of the operator to lift the column of water.

Some designs, such as the Tara (illustrated below) make this easier by using as the pump rod a plastic pipe filled with air, the buoyancy of which helps the upstroke operation. Other designs use very small diameter cylinders and rising mains to pump smaller quantities from greater depths.

In general, direct action pumps, being simple in action, are cheaper to buy and operate than high lift handpumps.



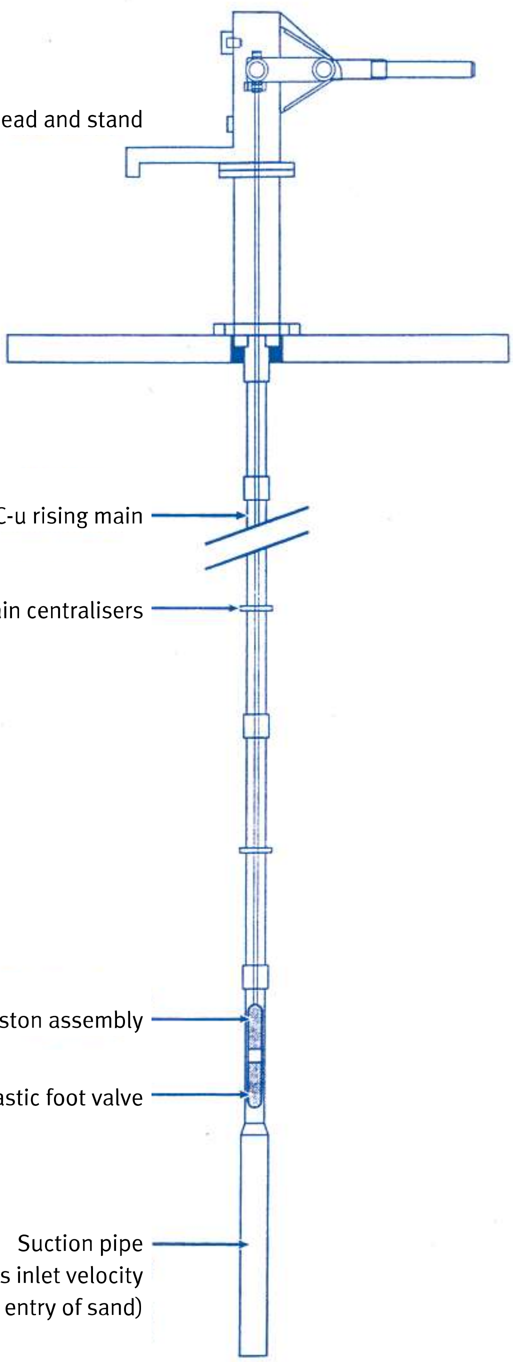
Intermediate and high lift (deep well) handpumps

An intermediate lift pump operates in the range 0 – 25 metres and a high lift one in the range 0 – 45 metres. Some of the high lift handpumps can operate at lifts of 60 metres or more, albeit with reduced output.

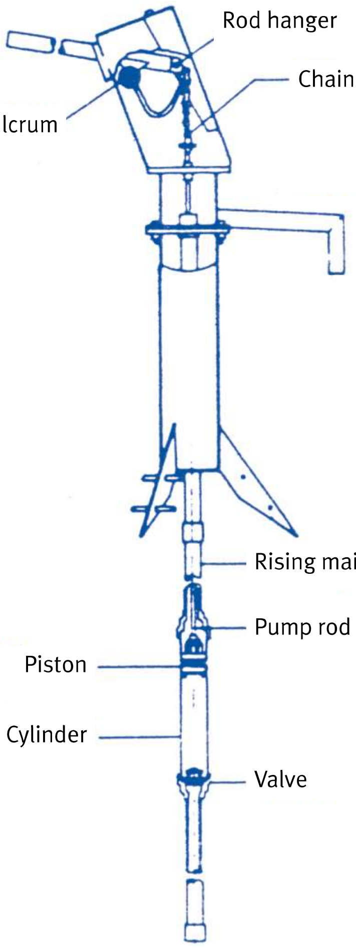
Intermediate and high lift piston handpumps are designed so as to reduce, by means of cranks or levers, the physical effort required when pumping. They have to be more robust and are provided with bearings and components capable of handling the larger stresses which are imparted by the pumping efforts required.

The Afridev handpump is shown in the following diagram and a more detailed one, showing the component parts, is given at the end of this section.

High lift 'Afridev' handpump



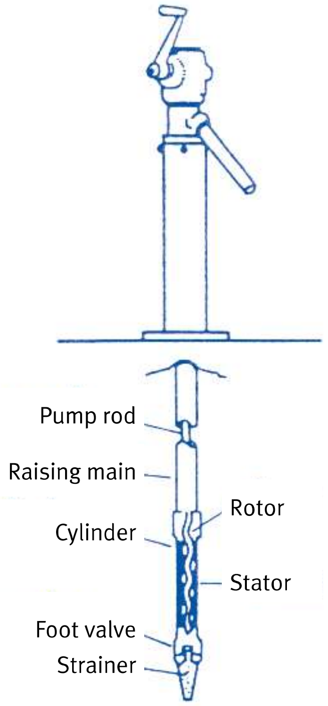
Deepwell reciprocating pumps



Non-piston pumps

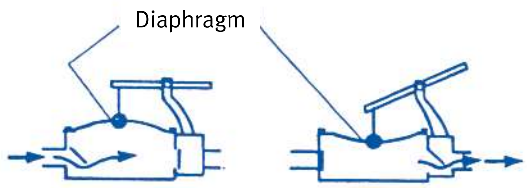
A high lift pump that is not a piston pump is the Mono progressing cavity hand pump; this has a rotating pump rod in the rubber stator within the pump cylinder, thereby producing a progressing cavity, which screws the water upwards. The meshing surfaces provide a moving seal.

Although a very reliable handpump, any maintenance task that requires removal of the rods and rotor assembly requires special lifting equipment.

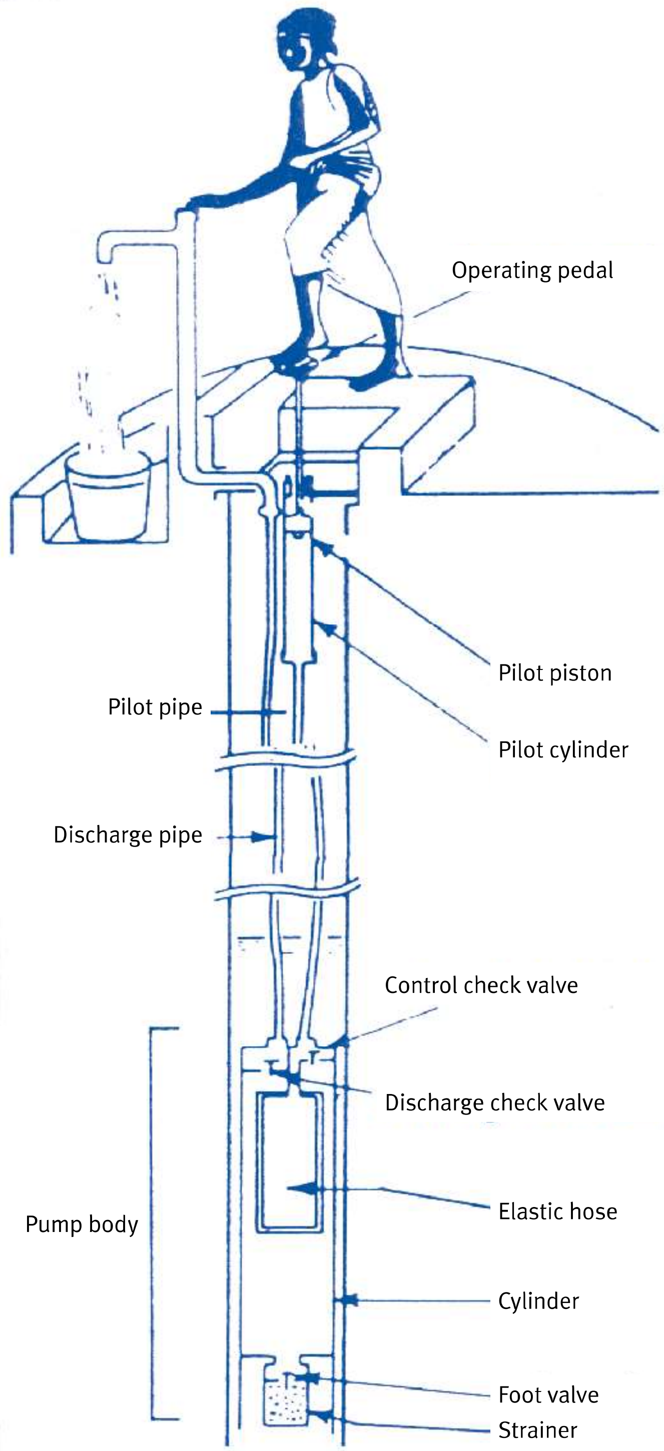


Diaphragm pumps

Another type of deep well handpump is the diaphragm pump.



This operates by the expansion and contraction of a flexible diaphragm within a closed system actuated by a secondary piston pump, itself actuated by a foot pedal or hand lever. The primary rigid cylinder has a suction valve and a delivery check valve. On the contraction of the diaphragm the suction valve opens to draw water into the primary cylinder and the discharge valve closes. When the diaphragm is expanded by operating the secondary system, the suction valve closes and the discharge valve opens to pump water up a flexible rising main. Although the pump is easy to maintain, replacement diaphragms are required at relatively short intervals; these are expensive and the cost is often beyond the capacity of village communities to fund repeatedly.



Choice of handpumps

The recommendations for handpumps which are proposed for use in community based water supply projects have been set out clearly in the World Bank/UNDP Handpumps Project (see Reference No.1 below). As well as the manufacture and performance specifications, the VLOM principles (see below) outline many attributes relating to ease of maintenance, local manufacture, robustness, standardisation, low capital cost and operating costs, availability of spares, community management and maintenance, etc.

When considering the most appropriate pump for a particular project, it is also important to take into account local preferences and government policy. The adoption of subsidised or 'free' handpumps by a major donor should be resisted if they are inappropriate and would not be sustainable in use.

Handpump performances

Typical performances of some common types of handpumps.

Name	Type	Lift range (metres)			Discharge rates (litres/min)			VLOM	Origin
Afridev	Deep well	7	25	45		22	15	Yes	Kenya, etc.
Afridev	Direct action	7	15		26	22		Yes	Kenya, etc.
Bucket pump	Improved bucket and rope	6	15		5	10		Yes	Zimbabwe
Consallen	Deep well	7	25	45	14	14	14		UK
India MK II	Deep well	7	25	14	12	12	12	No	India, etc.
India MK III	Deep well	7	25	45	50% of MK I				India, etc.
Monolift	Deep well progressing cavity	25	45	60	16	16	9	No	UK, South Africa
Nira AF 76	Deep well	7	25		25	26		No	Finland
Nira AF 84	Deep well	7	25	45	23	22	21	No	Finland
Nira AF 85	Direct action	7	15		26	24		Yes	Finland
New No. 6	Suction pump	7			36				Bangladesh
Tara	Direct action	7	15		24	23		Yes	Bangladesh
	Windlass and Bucket	0	45		5	15			Universal

Notes

Deep well handpumps are lever-operated reciprocating action pumps unless otherwise stated.

The VLOM concept

The term VLOM (Village Level Operation and Maintenance) was coined during the World Bank/UNDP Rural Water Supply Handpumps Project which, from 1981 – 91, considered the availability around the world at that time of handpump technologies and maintenance systems. A series of performance tests was undertaken: laboratory testing of 40 types of handpump and field performance monitoring of 2700 handpumps. It was concluded that centralised maintenance systems were the cause of many problems and that village level maintenance was desirable, but only feasible if the design of the pump made it possible.

Initially the VLOM concept was applied to the hardware, with the aim being to develop pumps which were designed to be:

- Easily maintained by a village caretaker, requiring minimal skills and few tools
- Manufactured in-country, primarily to ensure the availability of spare parts
- Robust and reliable under field conditions
- Cost effective

Subsequently, the VLOM concept was extended into software and organisational matters. Thus the "M" in "VLOM" has become "management of maintenance", for the success of a project was generally seen to be dependent on a strong emphasis on village management. Therefore the following elements were added:

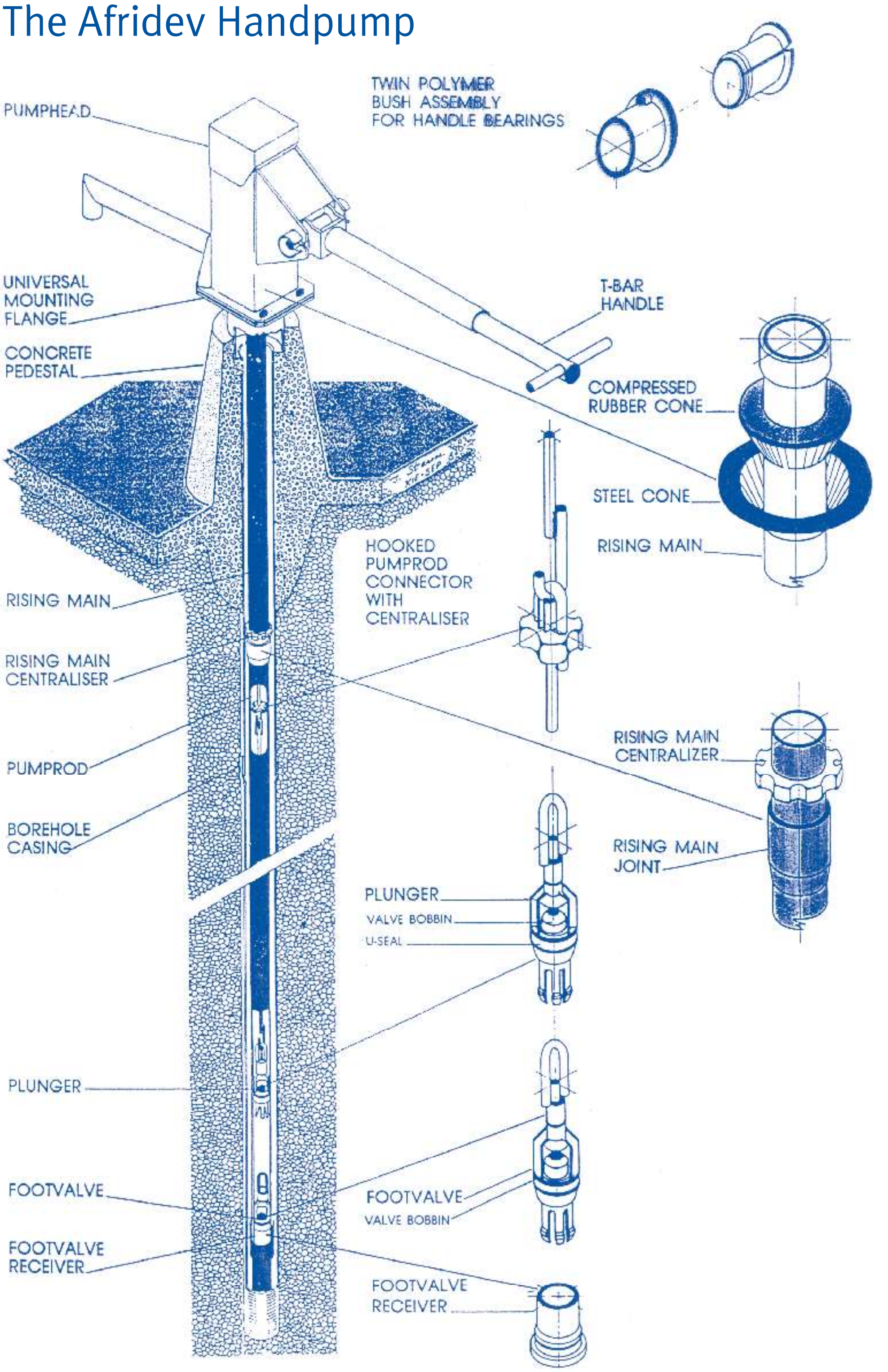
- Choice by the community of when to service pumps

- Choice by the community of who will service pumps
- Direct payment by the community to the caretakers

The application of VLOM principles, when considering pump selection, often involves compromising one principle to take advantage of another. A handpump with a low rate of breakdown might be thought preferable to another with a higher rate. However, a handpump that breaks down monthly, but can be repaired in a few hours by a local caretaker, is preferable to one that breaks down once a year but requires a month for repairs to be completed and needs replacement parts to be imported and skilled technicians to be available.

The Afridev handpump was developed during the course of the project to embody all of the VLOM design principles. Production began in Kenya in 1985 and modifications were made after field trials in Kwale in Southern Kenya. Improvements continue to be made. SKAT (Swiss Centre for Development Cooperation in Technology and Management) acts as a repository for the design drawings and specifications for the benefit of users and manufacturers of the handpumps. An exploded view of the pump is shown in the following diagram:

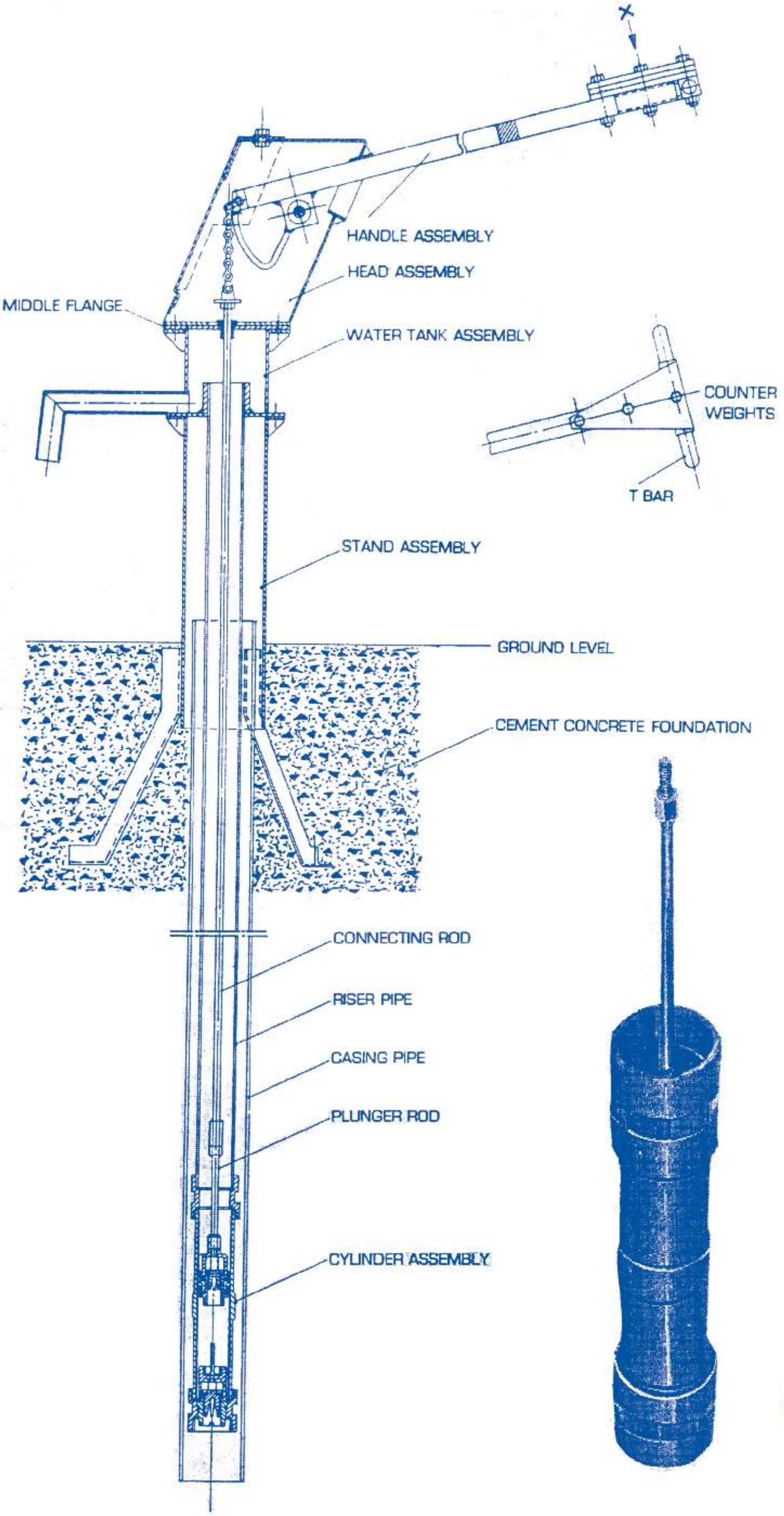
The Afridev Handpump

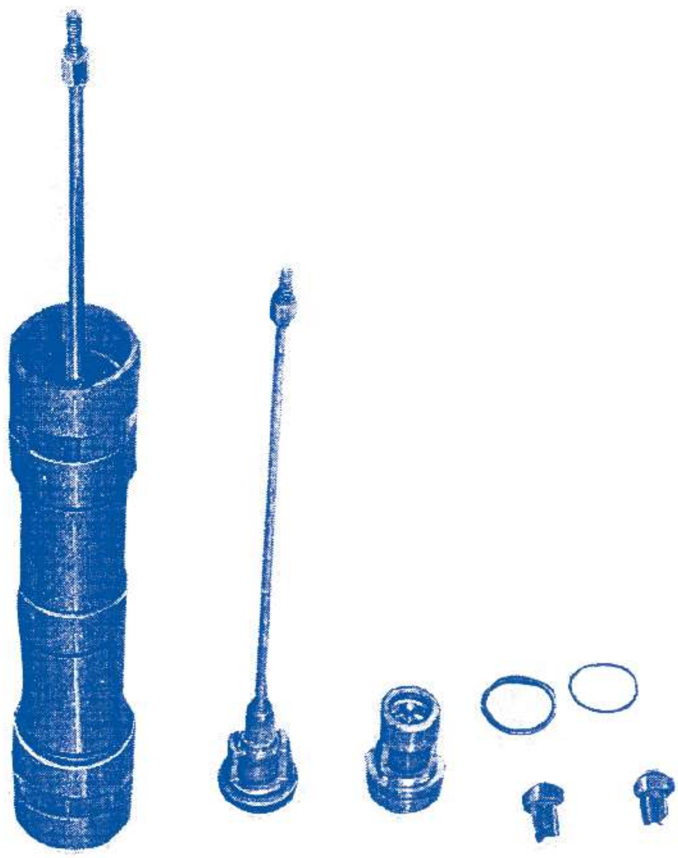


REFERENCES:

1. *Community water supply: The handpump option, rural water supply project,* UNDP/World Bank ISBN 08213-0850 1986
2. *Rural water supply handpumps project: Laboratory testing, field trials and technology development,* UNDP/World Bank Report No. 1 March 1982
3. **Reynolds J** *Handpumps: Towards sustainable technology – research and development during the water supply and sanitation decade,* UNDP/ World Bank Report No. 5

Meera Vlom India Mark IV extra deepwell handpump





CYLINDER WITH SINGLE PIECE PLUNGER AND CHECK VALVE