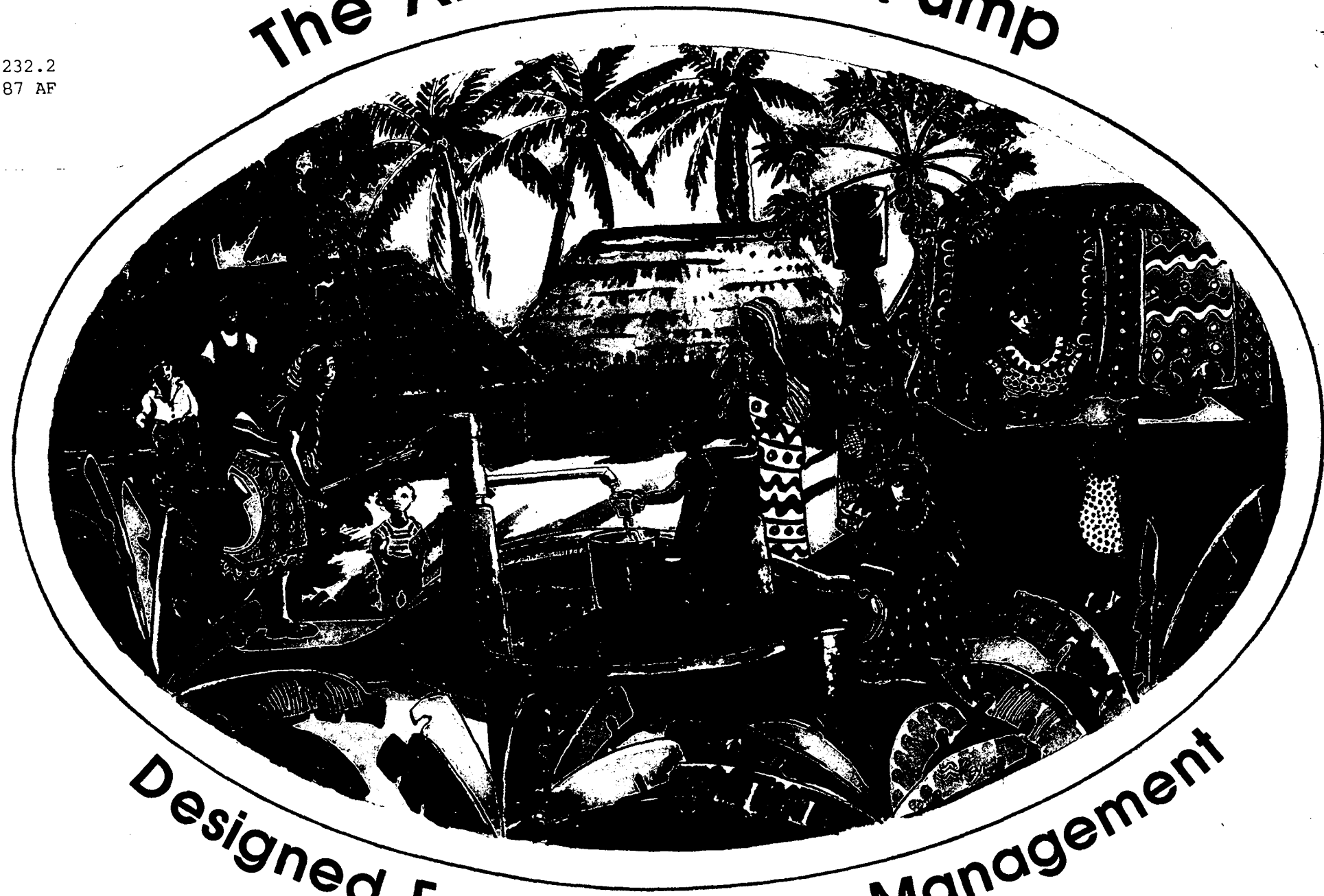
The Afridev Hand Pump



Designed For Community Management

The Afridev Pump:

* * is designed for very simple maintenance, using minimal skill and few tools.

* * is designed to minimise forces, without reducing the discharge, by using a small diameter, long cylinder.

* * is designed to minimise the number of spares by using the same cylinder size for all depths.

* * is designed to exploit modern materials and technology to simplify mass production and minimise corrosion.

* * is designed for local manufacture.

BACKGROUND

The **Afridev** started life in Malawi in early 1981. From the start, the aim was to produce a deep well handpump that was very easy to maintain at village level and could be manufactured in countries like Malawi, where industrial resources are limited. The **Maldev** pumphead went into production in early 1982, and was a significant step forward in head design, with the users' needs given first priority.

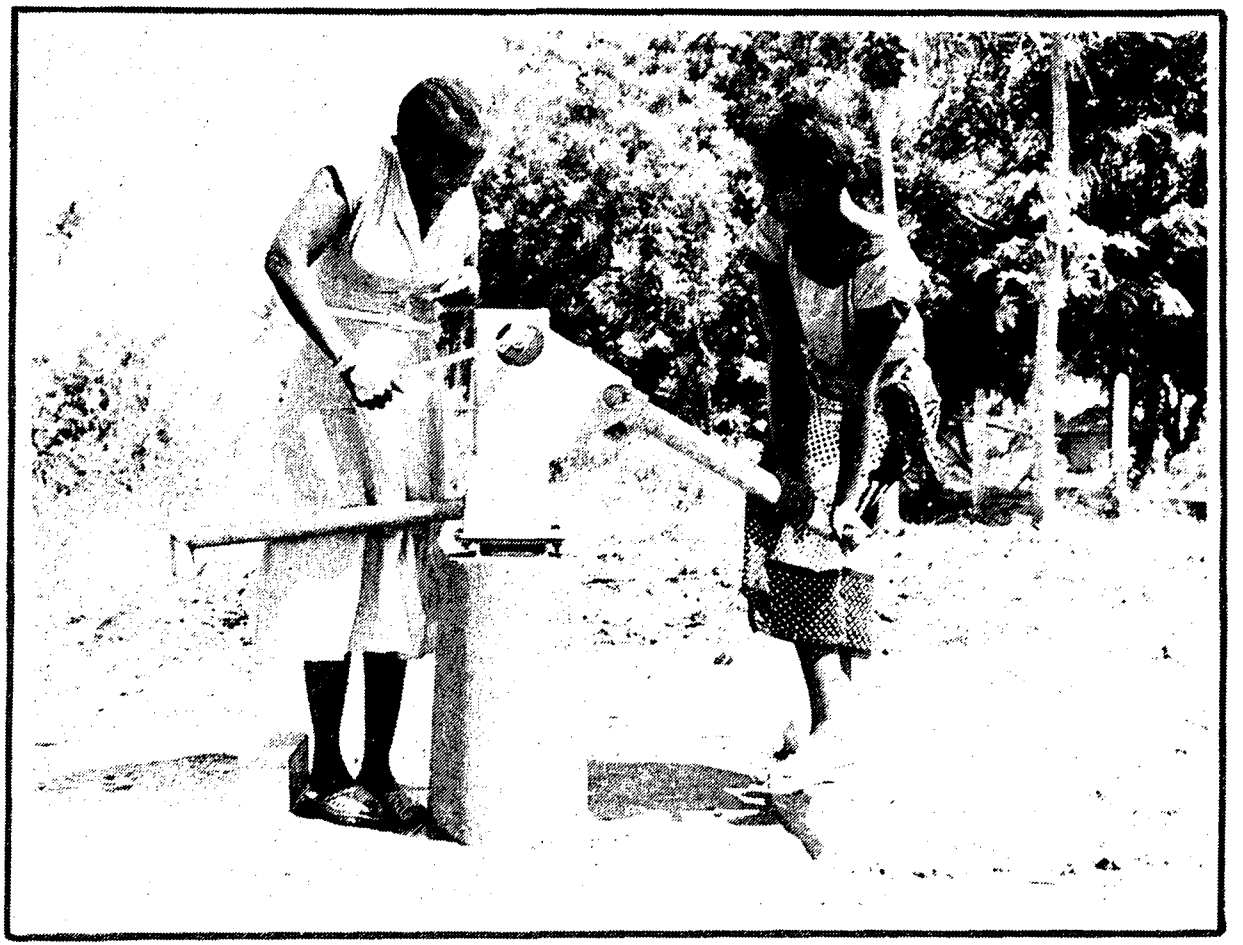
Early in the field-testing of **Maldev** pumps, the ball bearings caused problems and the first **Afridev** pumphead, which uses plastic bearings, was installed in Malawi in late 1982. Major efforts to resolve the "bearing problem" continued up to early 1985, when a plastic bearing design was finalised.

The focus of **Afridev** development shifted to Kenya in early 1983, although testing continued in Malawi and important contributions were being made by field workers in several East African countries, as well as by experts from organisations in Europe, who provided specialist advice or laboratory testing facilities. International handpump design meetings were held in Kenya in late 1984 and early 1986, and throughout this period design and testing of pumpheads, cylinders, rods and rising mains continued. At all times, the primary objectives were absolute simplicity of maintenance, and minimum quality control requirements to simplify manufacture.

Plastics research and development has played a vital role in the success of this project, of which the outcome is the **Afridev** pump system.

The **Afridev** handpump is now going into production and is demonstrating that deep well handpumps **can** be maintained by village men and women, **can** be manufactured in most developing countries and **can** still be affordable and reliable.

* * Simple Maintenance



Simple Maintenance

Simple Maintenance

* **Villagers can carry out all routine maintenance after a few hours training.**

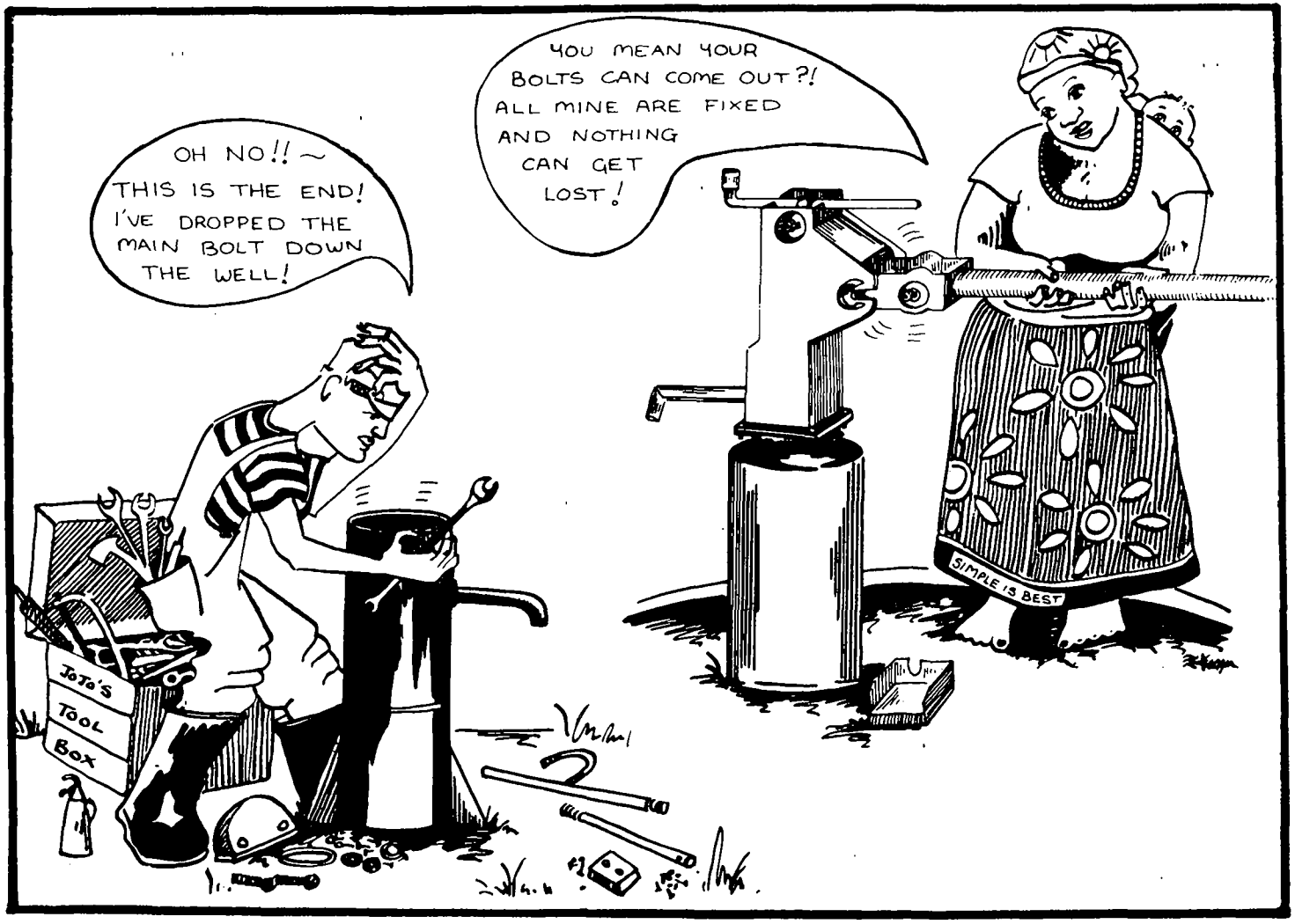
* **One spanner is needed to open the pumphead, replace the bearings and give access to the pump rods.**

* **Planned annual replacement of all wearing parts is recommended, and is quick and inexpensive.**

The pumphead is an all steel fabrication especially designed for easy maintenance and manufacture. The only maintenance needed on the pumphead is replacement of the fulcrum and hanger bearings. This can be carried out quickly and simply with a single spanner.

Routine annual replacement of wearing parts is recommended as this minimises both the risk of breakdown and the subsequent need for diagnosis of failure. This annual preventive maintenance will simplify training needs and spares purchasing, as well as sustaining skill levels through regular practice,

Simple Maintenance

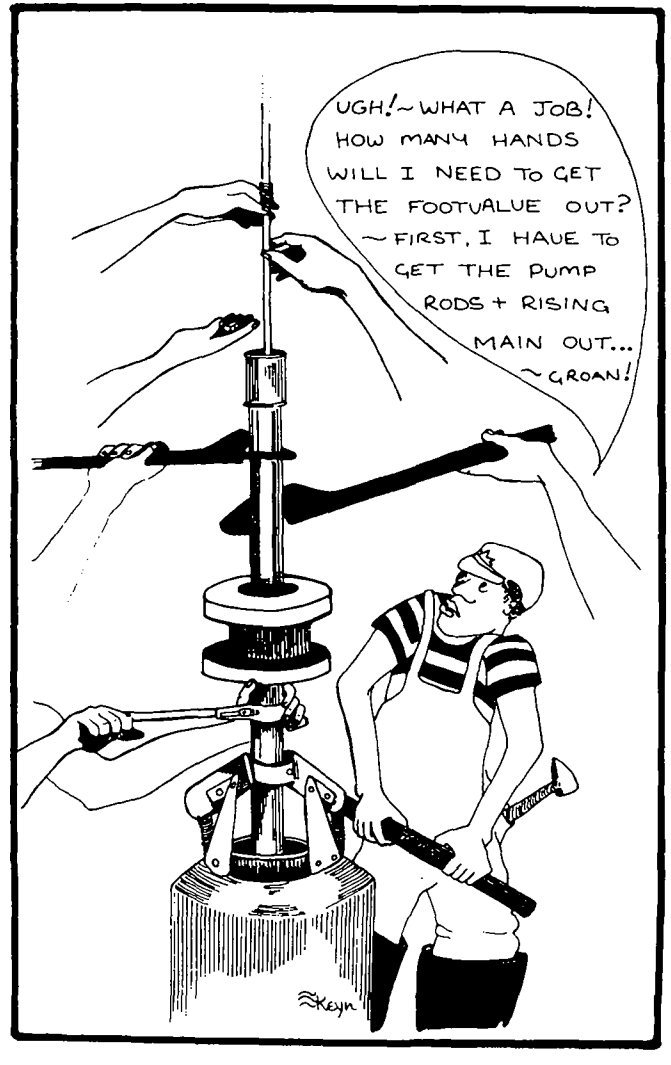


Simple Maintenance

* **For routine maintenance, nuts need only be slackened; they cannot be removed.**
* **All nuts and bolts are the same size.**
* **The spanner doubles as a rod-support and lifting tool.**

The nuts and bolts used to secure the pumphead cover and bearings are "captive", and only need to be loosened a few turns. This prevents nuts from being lost, dropped into the well or cross-threaded during routine maintenance. All nuts and bolts are M16. The spanner actually serves 2 purposes - to loosen nuts and to support pump rods suspended in the well.

Simple Maintenance



Simple Maintenance

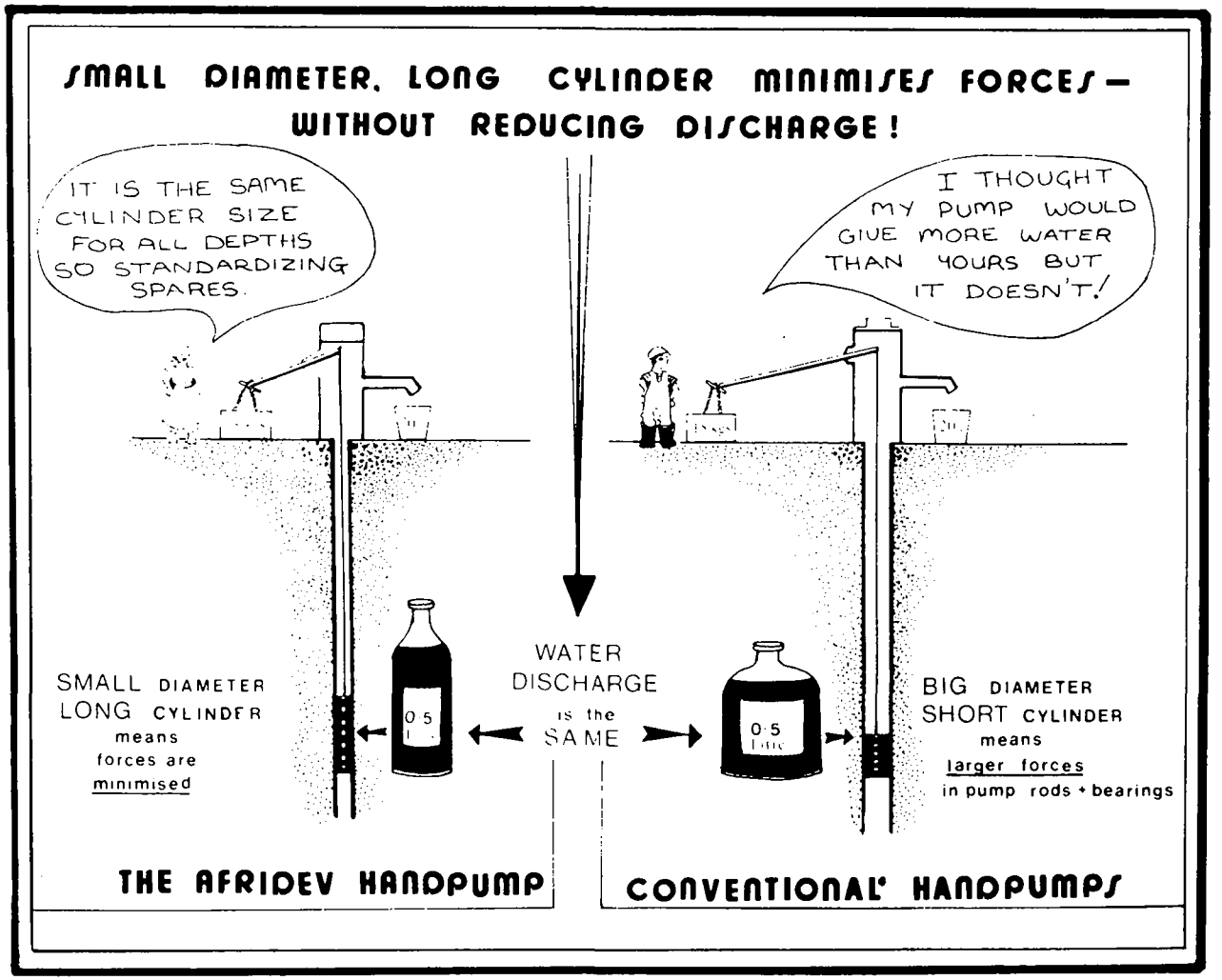
- **Lightweight, easy-connect rods.**
- **Two or three villagers can remove rods and plunger from a deep well without tools.**
- **The plunger and footvalve are identical components and have wearing parts fitted by hand.**
- **A small fishing-tool is supplied to remove the footvalve when necessary.**

Pump rods, made from galvanised mild steel or stainless steel, are joined without tools using special, easy-to-fasten hooked connections. Alternative, easy-fit rod connections are under development, to simplify mass production. Plastic centralisers locate the pump rods in the rising main.

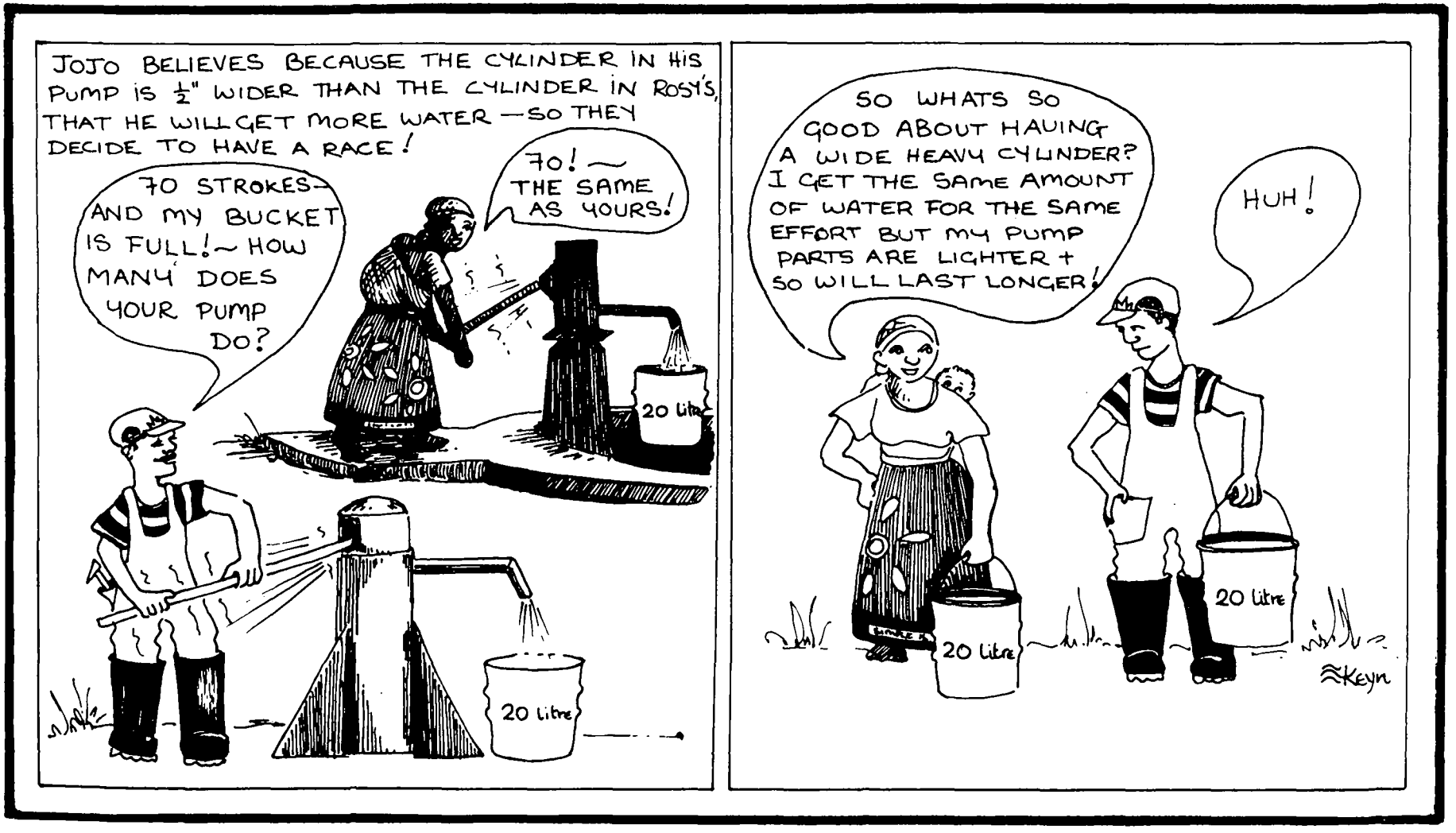
The footvalve is removed using a simple fishing tool fastened to the end of a rope.

** Small Diameter, Long Cylinder

** One Standard Cylinder Size



Small Diameter, Long Cylinder



Small Diameter, Long Cylinder

* **Pump design gives good yield from small diameter, long cylinder.**
* **Small diameter cylinder means reduced forces in the pump.**
* **Reduced forces mean lighter components which are cheaper, and easier to remove for maintenance.**

For a given handle effort and handle vertical movement, discharge from the small-diameter Afridev cylinder can be made identical to that of a pump employing a larger diameter cylinder and greater handle leverage. This is achieved by designing the Afridev handle system such that the swept volumes of the two cylinders are the same. An operator would be unaware of the differences in geometry between the pumps. However, for pump design and manufacture there are several important advantages in using a constant, relatively small cylinder diameter. Pump rod forces are reduced so that for a given stress, smaller diameter and therefore lighter pump rods can be used. These are cheaper and induce less inertia. Forces on the handle bearings are also minimised.

There are further advantages from using the 50 mm diameter cylinder. The use of a relatively small diameter cylinder means that moderate diameter rising main pipe can be used, while still retaining the facility to extract the plunger and footvalve. This is cheaper and minimises the weight of water in the rising main thus reducing static and dynamic forces on the uPVC pipe which is used for the rising main in the Afridev. In addition, smaller diameter borehole casings can be used.

One Standard Cylinder Size

One Standard Cylinder Size

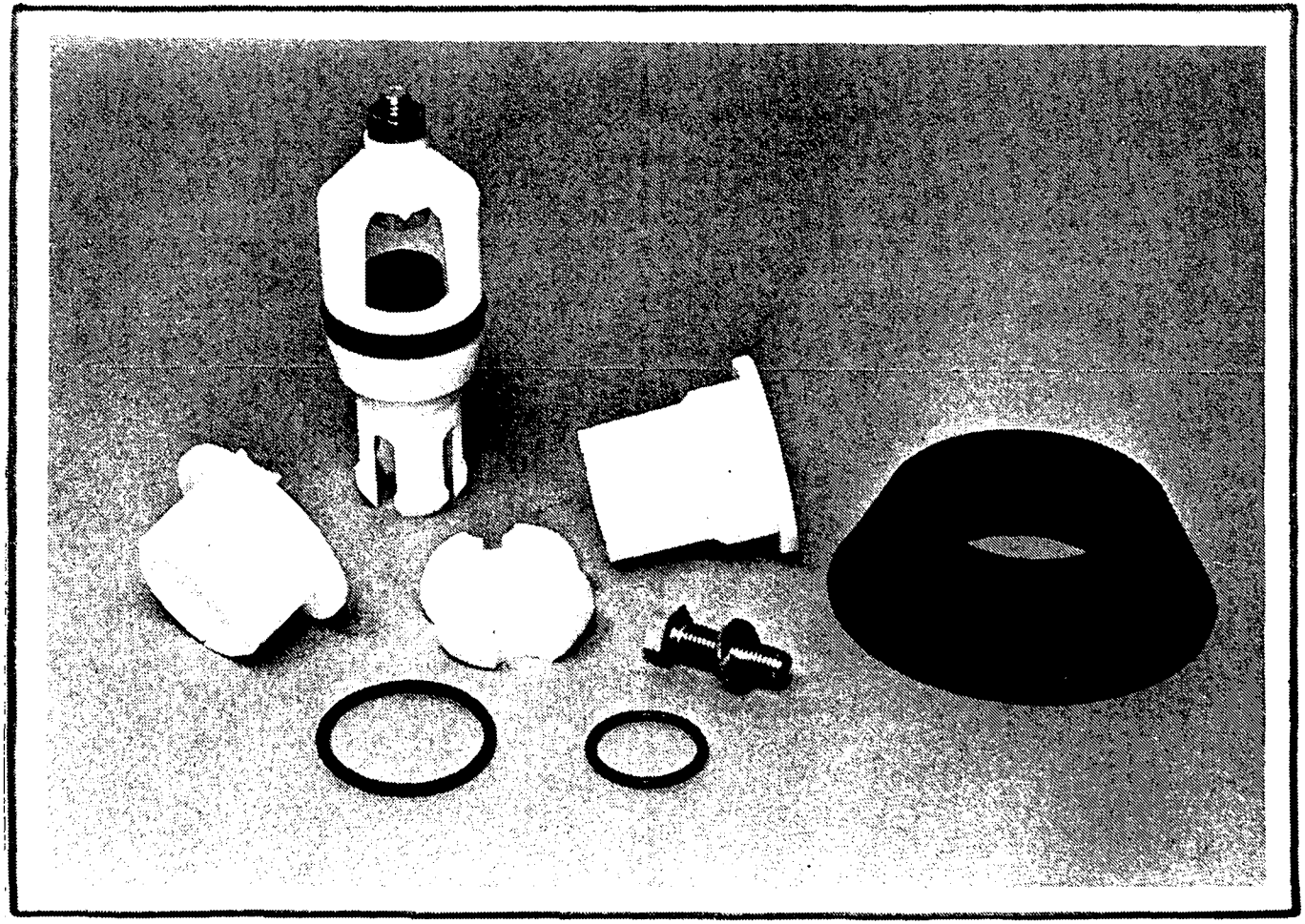
* **Optimized discharge from all depths resulting from variation of handle length, with one cylinder size.**

* **One standard cylinder diameter means that spares of only one size are needed.**

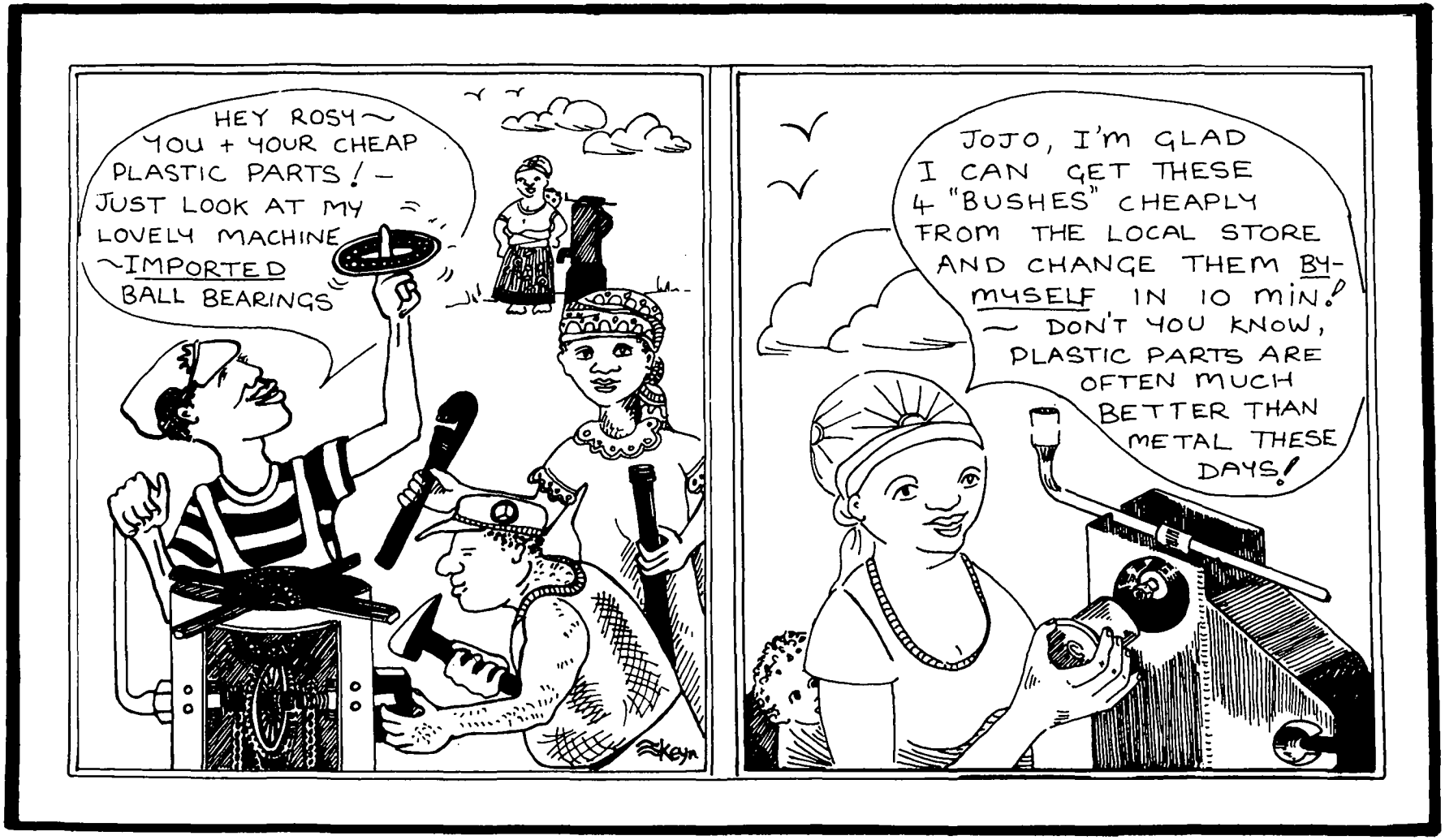
The use of a single 50 mm cylinder for all pumping depths challenges the conventional wisdom that a range of cylinder diameters should be provided. On the Afridev the mechanical advantage of the handle is altered instead, to ensure that pumping forces remain withing a range acceptable to users, whilst still giving similar yields per stroke for the same handle movement as that obtained with a larger diameter cylinder.

One standard cylinder diameter means that spares of only one size are needed. The spare parts stock is thus reduced and simplified, and the turnover of individual parts will be increased as one size fits all pumps.

**Modern Materials and Technology



Modern Materials and Technology



Modern Materials and Technology

* **Modern plastics are ideal materials for many pump components**
* **High quality plastic components can be mass produced at low cost.**
* **All the wearing parts of the pump are either plastic or rubber.**
* **Pumphead bearings use two parts of different plastics snapped together.**

The modern processes used in the design and manufacture of the Afridev have been available in industrialised countries for many years. Now they have been used to solve some of the problems of providing water supplies to rural communities in developing countries as well. For example, the Afridev pumphead bearings comprise a twin bush system that has an outer acetal bush running on an inner nylon sleeve which forms the counterface. The two parts snap together to give a neat, easy-to-replace bearing assembly. Field and laboratory tests have shown this material combination to have low wear characteristics while providing the great advantage that both bush and counterface sleeve are cheap injection moulded components. Expensive metal counterface pins, which all too often have a limited life, are thus eliminated.

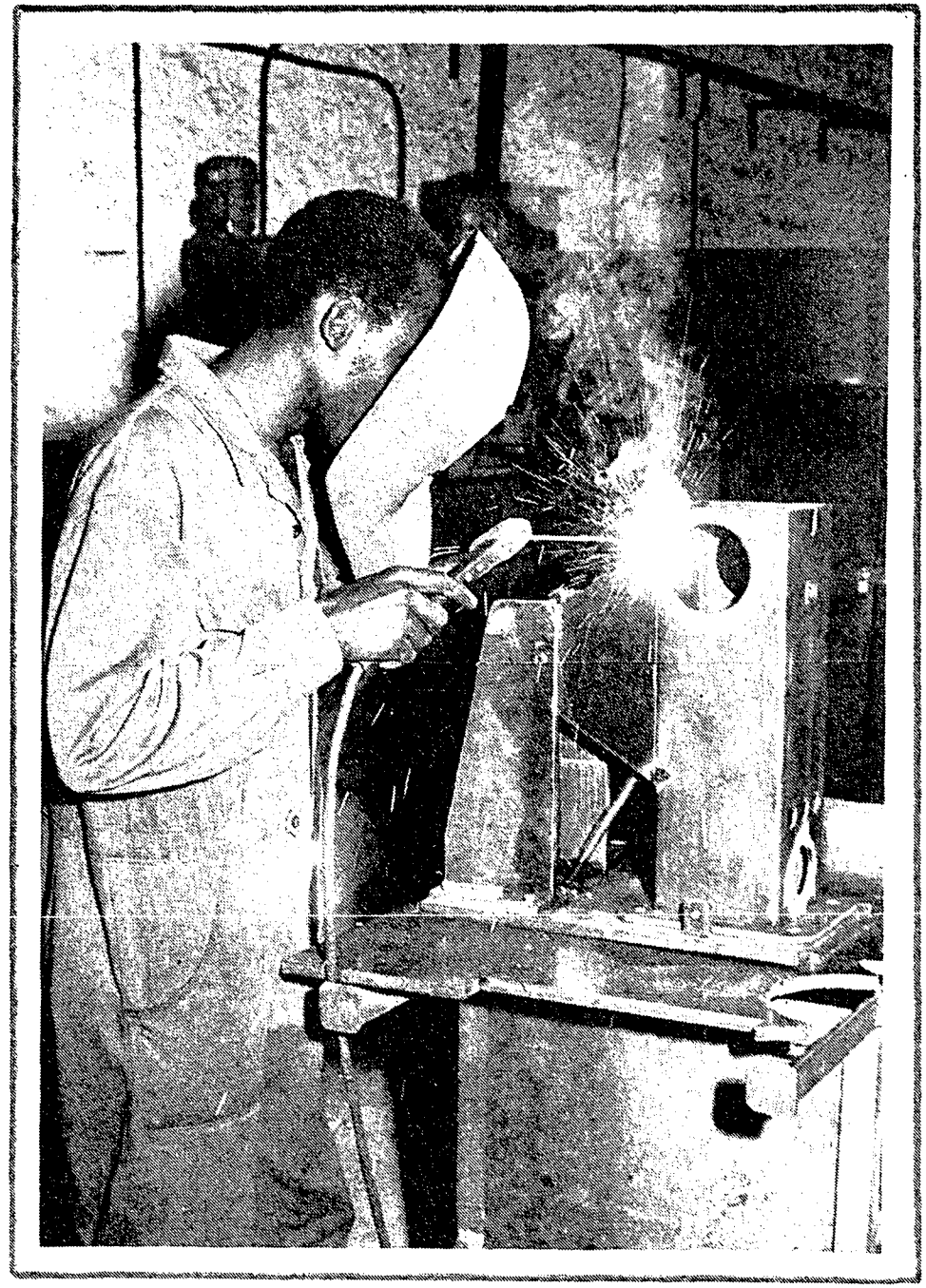
Modern Materials and Technology

Modern Materials and Technology

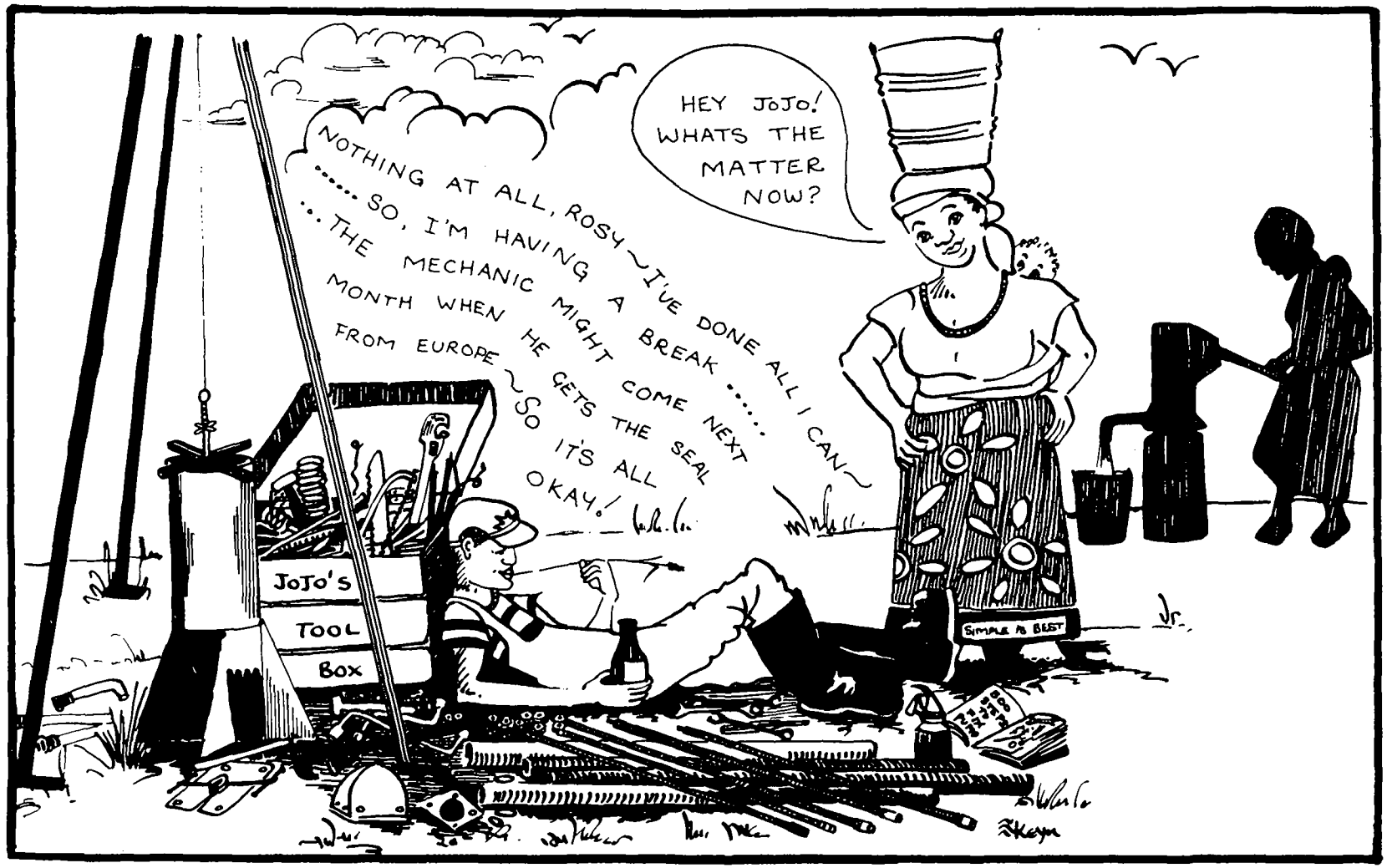
- **Complex looking parts can be moulded from modern plastics in most countries.**
- **Plunger and footvalve bodies are interchangeable and cannot be dismantled.**
- **The wearing parts of these components are snapped in place by hand.**

The plunger and footvalve are identical components, and consist of two mouldings permanently spin-welded together. In both cases a simple one-piece moulded rubber valve bobbin is used, and this " snaps" into the valve housing through one of the ports by hand. The plunger seal is also of the snap-on type, being fitted by hand and removed with the help of a household knife. The footvalve is located in a receiver at the bottom of the cylinder, and again, a snap-fit is used. A simple "fishing" tool, consisting of a small grappling device on the end of a length of rope, grips the footvalve so that it can be removed for maintenance.

** Local Manufacture



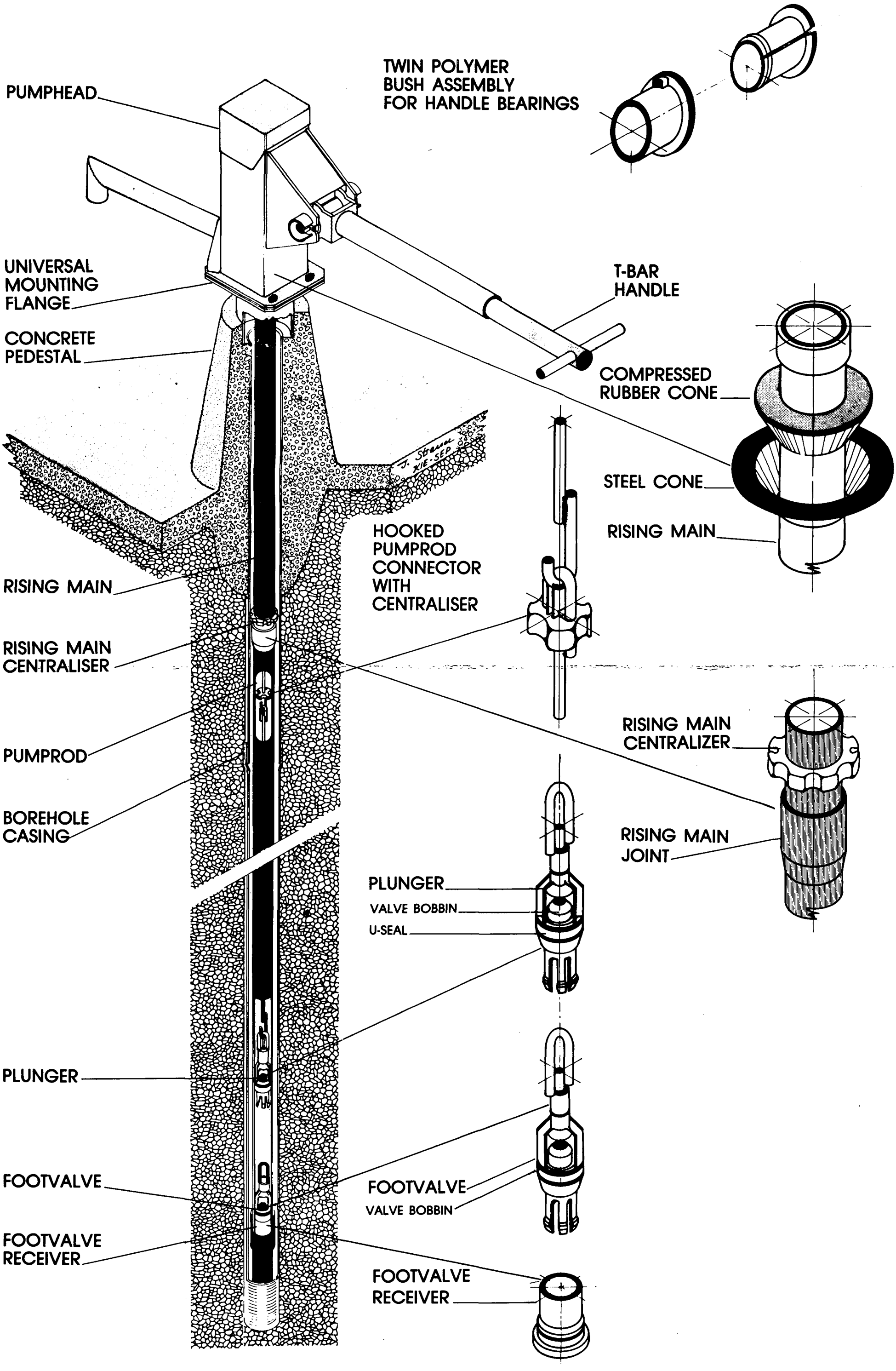
Local Manufacture



Local Manufacture

- **Local manufacture means local distribution of pumps and spare parts without foreign exchange and import licenses.**
- **Local distribution means that villagers can buy parts for their pumps.**
- **Straightforward pump design uses off-the-shelf materials wherever possible and simple manufacturing processes, with minimised quality control**
- **Pump design is adaptable to take account of local needs and resources.**

The pumphead is an all-steel fabrication specifically designed for easy manufacture. It consists largely of stock sections and incorporates a minimum of close tolerance machining. Widely available extruded uPVC is used for the rising main. Pump rods can be fabricated locally. Rubber is used for the valve bobbins and plunger seal and can also be locally moulded. Plastic components (bearings, plunger/footvalve, rod centralisers) are all designed to be locally moulded. Cylinders are also produced in Kenya using mainly locally manufactured components, although stainless steel cylinder liners are imported.


PUMPHEAD
UNIVERSAL MOUNTING FLANGE
CONCRETE PEDESTAL
RISING MAIN
RISING MAIN CENTRALISER
PUMPROD
BOREHOLE CASING
PLUNGER
FOOTVALVE
FOOTVALVE RECEIVER
TWIN POLYMER BUSH ASSEMBLY FOR HANDLE BEARINGS
T-BAR HANDLE
COMPRESSED RUBBER CONE
STEEL CONE
RISING MAIN
HOOKED PUMPROD CONNECTOR WITH CENTRALISER
RISING MAIN CENTRALIZER
RISING MAIN JOINT
PLUNGER
VALVE BOBBIN
U-SEAL
FOOTVALVE
VALVE BOBBIN
FOOTVALVE RECEIVER

Technical Specification

Pumphead

- All steel, welded fabrication designed for easy manufacture.
- Hot dipped galvanised (alternative finishes can be used).
- Universal mounting flange with 180 x 140 mm bolt centres provides interchangeability with India Mark II and Maldev.
- All nuts and bolts are M16, and those loosened for maintenance are captive.
- T bar handle for easy 1 or 2 person use, with handle force not exceeding 20 kg-f, with:
  3:1 advantage for 10 - 30 m lift.
  4.5:1 advantage for 30 - 45 m lift.
- Direct-action pumphead for up to 10 m lift under development.
- Concrete pedestal recommended for low-cost, rigidity and contamination protection (steel pedestal can be used).

Handle Bearings

- Twin polymer bush assembly specially designed for pumphead hanger and fulcrum bearings.
- Twin bushes using outer polyacetal bush (Delrin 500) running on inner nylon 66 bush (Zytel 101).
- Two parts snap together to give neat, easy-to-replace bearing unit.
- Field and laboratory tests indicate very low wear rates
- Cheap, mass-produced spare part.

Rising Main	—	63mm OD, 53mm ID, 15 bar uPVC pipe.
	—	Suspended from pumphead by compressed rubber cone, giving simple joint that eliminates load concentration.
	—	Solvent welded uPVC pipe joints (snap together, easy-fit joints are under development).
	—	Rubber centralisers to locate rising main in borehole.
Pump Rods	—	Hooked 10 mm galvanised mild steel rods, with stainless steel option at extra cost for corrosive groundwater.
	—	Joined by special, easy-connect hooks, eliminating threads and tools.
	—	Hook connection incorporates plastic rod guides.
	—	Alternative, easy-fit rod connections are under development, to simplify mass-production.
Cylinder*	—	50 mm ID (53mm OD) x 700 mm long stainless steel (304) tube sleeved into 63mm OD, 53mm ID 15 bar uPVC pipe.
	—	Stainless steel cylinder lining ensures long life and corrosion resistance.
	—	Incorporates polyacetal (Delrin 500) footvalve receiver.

*Note: The discharge per full stroke (225 mm) is 0.44 litres. However, this much-quoted measurement is virtually irrelevant, as users rarely use this full stroke. A typical user moves a pump handle about 300mm, and the discharge for this typical handle movement will then depend on the mechanical advantage of the handle and the cylinder diameter. The Afridev aims to optimise the discharge for this typical stroke length at any given pumping head.

— Employs 1m long, 75 mm OD x 67mm ID suction pipe to give low water velocities thus minimising sand transport.

Plunger/Footvalve

— One component used for body of both plunger and foot-valve.

— Valve body comprises two injection moulded parts, permanently spin-welded together.

— Valve body is polyacetal (Delrin 500), an engineering plastic with excellent mechanical properties and low water absorption.

— When used as footvalve, the snap-legs on valve body "plug-in" to receiver at base of cylinder.

— When used as plunger, valve body uses snap-in rubber "U" seal, fitted by hand and removed with a household knife.

— A simple, one-piece, moulded rubber bobbin is used in plunger and footvalve, snapping into valve body by hand through one of the ports.

Tools

— Only two required.

— Forged socket spanner 24 mm across flats.

— Footvalve "fishing" tool uses simple grappling device on end of rope.

Spare Parts Pack

— For routine replacement of wearing parts, a spare parts pack is provided. This comprises 4 plastic bearings, 1 rubber seal, 2 rubber valve bobbins and 1 "O" ring.

Afridev Production

The Afridev is now in limited production in Kenya. About 300 pre-production pumps had been produced by the end of 1986 by several different manufacturers. Following field trials of these pumps, a few design modifications are being made in early 1987. Large scale production is then expected, and full quality control systems will also be implemented. Production of the pumphead has also started in small numbers in Malawi, as a second generation Maldev (or Malawi pump). It is planned that tooling up for production of cylinders and bearings in Malawi will be undertaken by a manufacturer during 1987. Production of the Afridev, in modified form to suit local conditions and known as the Ibex pump, has started in Ethiopia and will be consolidated during 1987.

A production manual is also planned. This will be a comprehensive but straightforward document containing all the information needed to manufacture the pump. As well as drawings, it will include data on jigs and fixtures, gauges, materials and production processess. All this information is in the public domain and will be available to any potential manufacturer, in any country.

Pump Prices

The target price in Kenya and Malawi (inclusive of duties) of a complete pump to 30 meters is approximately $450. Components will be available separately if required. The price of a spare parts pack (containing all routinely wearing parts) for the proposed annual scheduled maintenance is around $12. Villagers should be able to purchase spares from a village store or a local bicycle mechanic, and the price quoted includes a margin for distribution costs and profit.

Acknowledgements

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For further information on the Afridev handpump, its suppliers, and the production manual, write to:

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Nairobi, Tel: 338868.
Kenya. Tlx: 22022

This booklet has been produced by the East African team of the UNDP/World Bank Rural Water Supply Handpumps Project (INT/81/026), in order to explain the main principles of the Afridev Handpump, a pump that demonstrates that villagers in rural areas of developing countries can manage their own water supplies. It is hoped that this will encourage other designers and manufacturers to work towards similar targets of village level operation, maintenance and management (VLOM), as well as local manufacture.

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