

PRACTICA

Foundation

Rope Pump Manual, Ethiopia

Hand dug well & Borehole model

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Photo on cover:

Women using a new installed Rope pump

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Introduction

This manual is made as a guide for organizations and workshops which are involved in the introduction process of the manually operated Rope pump and for technicians to be trained in Production, Installation and Operation & Maintenance of the Rope pump models: 'Hand dug well' (AH) and 'Borehole' (AB).

Experiences indicate that for a successful introduction, production and installation of Rope pumps on a large scale, the use of any production and installation manual has to be combined with hands-on training by an experienced trainer! The trainer will guide the organization and/or workshops through all aspects of the introduction and production process. Lessons learned from the past show that a number of small mistakes usually are made during the first years of production. However, these minor 'mistakes' can have a large influence on the life time and functioning of the pump. If these impurities are not corrected in time by a professional, the Rope pump option will gain a negative image amongst users and others in an almost irreversible way!

It is therefore that it is strongly suggested this manual will only be used in combination with a professional training, whereby the manual will be distributed to the participants, who can later use it as a reference handbook. The practical training will focus on all essential aspects for producing and introducing the Rope pump.

Modules

The Manual consist of four modules:

- 1 Introduction to the Rope pump
- 2 Production
- 3 Installation
- 4 Operation and Maintenance

The four modules can be used separately:

- All four modules together are meant for organizations and/or workshops which are involved in the complete introduction process.
- Modules 2, 3 and 4 are meant for the producing workshops.
- Modules 3 and 4 are meant for distributors and installation technicians.
- Module 4 can be plasticized and distributed to users when they obtain the Rope pump.

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MODULE 1:

INTRODUCTION TO THE MANUALLY OPERATED ROPE PUMP

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1.1 General Aspects

1.1.1 Context

A commonly used device to pump up water, from hand dug wells or boreholes, is a piston pump, which has a reciprocating movement. Another option, with a rotating movement, is the so called 'Rope pump'. New models of Rope pumps are based on the ancient principle of the 'Rope and washer' pump. With new design inputs and modern materials, improved Rope pumps are now very efficient, reliable and affordable and pump up water from wells with a water level as deep as 35 meter.

1.1.2 Type of hand pumps

Hand pumps can be divided in suction pumps and lift pumps.

Suction pumps

The piston is situated on ground level. Water is sucked upwards by the piston because of the relative under-pressure below the piston. Theoretically the suction head of a suction pump is 10 m., unfortunately in practice this is 6 to 7 m. A good example of a suction pump is the 'Treadle pump'. These pump types are relatively inexpensive and can be produced and repaired locally.

Lift pumps

Piston pump: The piston is now situated below the water level. Water is forced upward by the piston (positive displacement). In general, pumps of this type are more expensive, as it requires long pump rods and rising mains. Examples are the Nira-, Afridev-, Indian Mark- and Volanta pump. It is not easy to produce these pumps locally and most of these pumps and their spare parts have to be imported.

Rope pump: The Rope pump is a lift pump with continuous upward movement of a rope and a number of pistons in a tube. The Rope pump has a relative lightweight construction and is made of locally available materials and can be produced and repaired locally.

1.1.3 The advantage and disadvantage of the Rope pump.

Advantages

- Low cost, a cheap pump on household level (<10 households).
- Absence of dynamic forces (rotating movement).
- Tubes can be made of low pressure PVC tubing.
- The total weight of pump parts is approximately 15 Kg (which is 5 to 10 times less than piston pumps). The pump can be taken from the well without any lifting tool.
- No valves, valve seats, and ball bearings. Therefore less 'critical' parts, resulting in higher reliability.
- High overall efficiency 80 – 85% (if well made).
- Technology, without 'black box', is easy to understand, produce and maintain.

Disadvantages

- The Rope pump is not 100% closed. At the discharge and return tube, the pump is open to the air and contamination of the rope is possible via contact by hand.
- The Rope pump is not a pressure pump (no pressure in outlet).
- Especially with deep wells, it takes some time before the Rope pump delivers water. (When not in use, the water level in the pump falls back to the water level in the well).
- The Rope pump is NOT designed for communal use by more than 10 households.
- "Stone age" image. Many people know the Rope pump as a self made, low lift pump. This image hampers acceptance by water organizations, institutes and users.

Evaluations show that 90% of the Rope pumps continue working, even after years of operation. This high percentage is due to the simplicity of the pump. The users understand the working of the pumps and are able to maintain it and, if necessary repair it themselves or with the help of a local workshop 'around the corner'.

1.2 The Rope pump

1.2.1 How it works

The Rope pump consists of a wheel and an endless rope with small pistons, made of polyethylene (or car tire in home made models) that are attached to the rope at intervals of 1 meter. The pistons fit, with a clearance of around 1 mm, in the PVC pipe called 'rising main'. The rope and pistons move freely (and not in a pipe) down into the well. At the bottom, the rope is led by a guide box into the rising main. The wheel and handle are mounted on a support structure on top of the well. The rope and pistons are lifted by the wheel. The water is brought up by the pistons and discharged at the surface. When an additional wheel is added it can even be higher than ground level. Rope pumps can be used on open hand dug wells or boreholes with a diameter as small as a 3 inch (75 mm).

The Rope pump can be classified as a positive displacement pump producing a constant output, unlike the pulsating flow of piston pumps. The weight of the water column is equally carried by all pistons in the rising main. The pressure built up in this tube is only the height of the water column between two pistons (1 m). As a result, the forces on the pistons and the radial water pressure on the rising main are small, making the use of 'thin wall' or 'low pressure type' PVC pipes possible. In a piston pump (with a foot valve) the pressure would be created by the height of the entire water column. The maximum force on the rope is determined by the volume of the water column in the rising main. The continuous flow not only reduces peak forces on the rope, but also maximizes the effective flow of water through a given tube diameter. Finally, the absence of peak forces and the gradual filling of the pump tube, contribute to good human ergonomics. The Rope pump has a relative lightweight construction and is made of local obtainable materials (for drawings, please see module 2 and Annex II).

1.2.2 Various Rope pump models

The manually operated pump models

The manually operated Rope pump models can be divided in options for boreholes (tube wells) and hand dug wells. The choice for the model to be used depends on the well type and the budget of the owner.

The following three models are available:

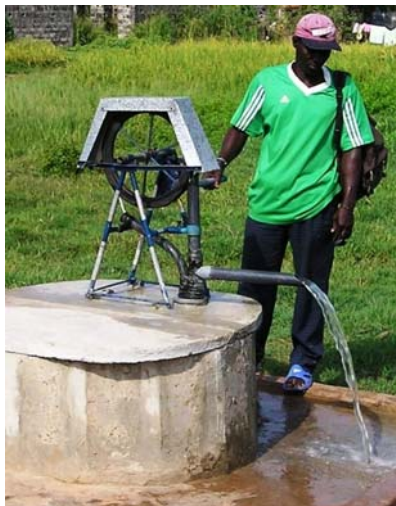
- The **AB Model** is designed for boreholes (tube-wells).
- The **AH model** is designed for hand dug wells and preferably includes a concrete well cover.
- The **Pi Model** is sometimes used on hand dug wells on household level.

The major difference between the AB, and the AH model is the length of the frame. The most ergonomic pose and the strength of the arm muscles are optimal when the axle of the pump is situated at elbow (belly button) height. The cover of most existing hand dug wells is constructed higher than ground level, while most of the borehole casings (tube wells) are cut off just above the ground.

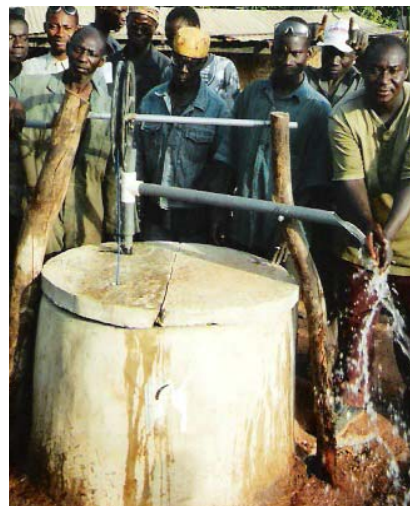
The Pi model is constructed on wooden poles, which are sometimes already installed besides the hand dug well, and can be used on single household level. Although the Pi model is cheaper than the two A models it is not recommended to use it during the introduction of the Rope pump as alternative pump option. The durability of the Pi model is less than the regular A models and it is wise to wait with its introduction until the Rope pump has build up a name as a reliable and sustainable pump. This manual will only describe the AB and AH model.



AB (A model, Borehole)



AH (A model, Hand dug well)



Pi (Pi model, Hand dug well)

Other pump models

For higher yields, special models were developed powered by pedals, electric motors, gasoline engines, animal traction and wind mills. Of all special options the motorized Rope pump is most promising, with a high yield making the Rope pump suitable for irrigation.

1.2.3 General data of the Rope pump

| | |
|---|---|
| Discharge ¹⁾: | Water level, up to 10 m depth: 35 liter/min up to 20 m depth: 20 liter/min up to 35 m depth: 10 liter/min |
| Maximum depth: | 35 meter (water level) |
| Input power ¹⁾: | approx. 50 Watt |
| Discharge level: | 1 m above ground level (no pressure) (with an additional wheel and structure up to 6 m above ground level) |
| Application: | 1 – 10 households (approximately 50 users maximum) |
| Cost: | € 40 - € 90 (depending on model and country) |
| <i>Re 1): The discharge is based on an input power of approx. 50 Watt, which is the power that women and children can deliver for longer periods.</i> | |

1.3 Introduction and dissemination

1.3.1 Quality

Although the Rope pump technology seems (and is) simple, there are still many details in production, installation and use which needs attention especially in the first years of production and introduction.

Experiences in a lot of other countries have learned that drawings or a technical training alone is not enough to ensure the quality of the first produced pumps. The workshop trainees usually have a lot of practical experience, but often didn't attend school for a long period of time. This often creates a lack of basic fundamental knowledge on mathematics and physics, which are useful during construction and installation of the pump. During a training course the students gain a lot of background and practical information, but there is always a chance that small mistakes will be made in construction, installation or in the maintenance training they provide to the users, after the training course is over. Unfortunately, these minor mistakes can have a large influence on the life time and functioning of the pump.

Therefore quality control is crucial in the phase of introduction when the Rope pump still has to build up a name as an accepted, reliable and sustainable pump by manufacturers, users, government, NGO's and donors.

If the quality of the pumps, produced in the first years, is bad and results in broken or rusted parts, the Rope pump will build up a negative name amongst users in an almost irreversible way! As a result the pump will be rejected. Unfortunately this is a hard lesson learned in a number of countries.

1.3.2 Monitoring

Part of effective quality control is monitoring, which will create an overview, making it able to detect problems in time. In order to make this easy, it's recommended to mark the pumps with a serial number and the initials of the workshop. The workshop owners will keep a log of the produced pumps and note down:

- Pump number
- Production, Selling and Installation date
- Name of the buyer and place of installation
- Model
- Price

After a production period of 6 months or 30 pumps, it is strongly recommended to evaluate the encountered problems, using the inventory, with the producers and users of the pumps during a follow-up training by an experienced trainer. Using field visit as a base, the students can be trained in correcting occurring problems at existing pumps and future production. In order to keep monitoring transparent it is not recommended to have more than 5 workshops trained at the time. Please, see Annex I for a technical checklist, which can be helpful during monitoring.

1.3.3 Marketing

Strategies

As the Rope pump is fairly unknown by most people at first introduction, it is recommended to bring the pump under the attention of the public and establish a connection between the potential buyers and the producing workshops. In general the media is a useful tool to reach people. Especially if people are known as rather conservative, it is important they come in contact with the Rope pump through several different sources such as: radio, TV, newspaper, magazines, distributed flyers and demonstration models.

Starting this marketing procedure, it is important to realize what information is important to the public. First of all it is important to note on which wells and water levels you can apply the pump, in short it's working, application (household level), flow rates, the price and in which way they can get more information or obtain the pump.

Price and name

It is recommended to calculate a standard price for the hand dug well- and borehole model. Note that the manufactures need profit to continue production, but be aware that the price will stay 'low', in reach of the user's budget. By announcing the price during marketing, misuse of the monopoly position of the workshops in their region is avoided.

As a lot of potential users don't speak English, it is advised to choose a name in local language for the Rope pump.

Demonstration models

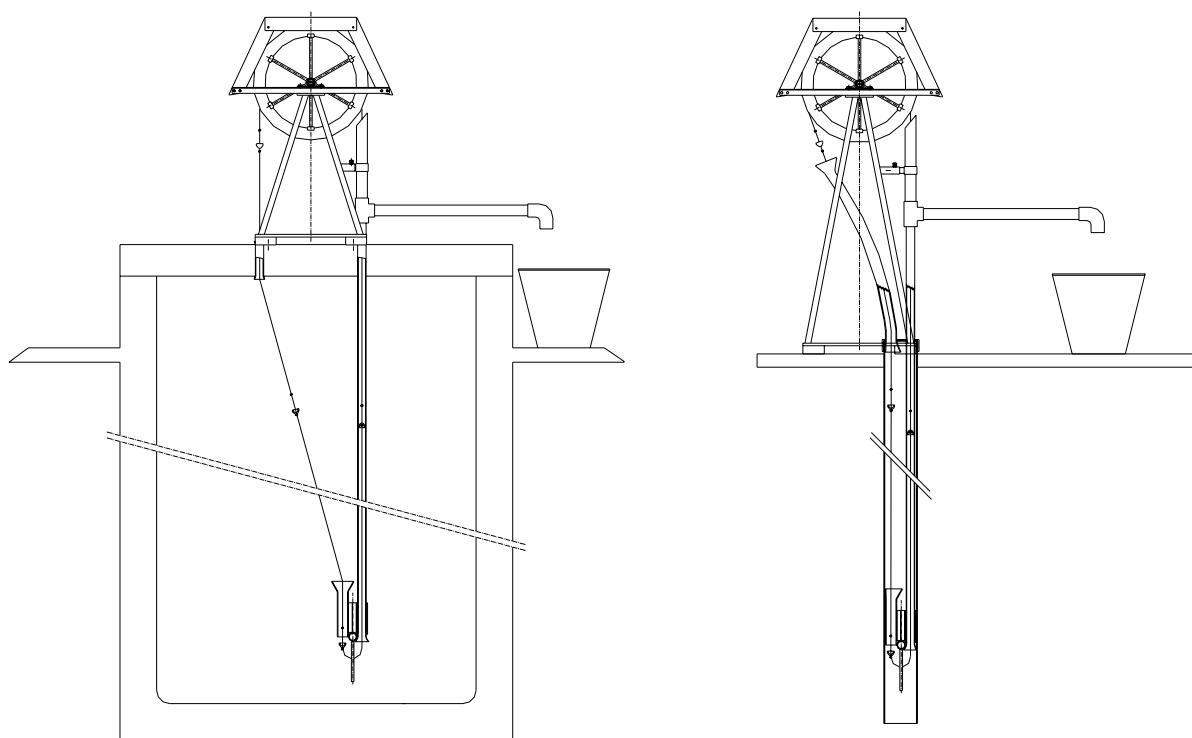
Seeing and trying is believing! Especially when people are conservative and low in budget, they will not invest in a, for them expensive, pump before they're convinced of its working and quality. Not only the quality of the pumps has to be good, they also have to be 'good looking' and professional, all to convince the public in the first phase of introduction.

Until a 'critical mass' is reached and the Rope pump fully accepted by the public, marketing will be necessary. Once enough people know about the pump and are convinced of its working, information on the pump will get spread through social contacts among people by itself, making marketing less important. Unfortunately, reaching a 'critical mass' is not an easy task.

The role of thump in this is: It's better to place 20 demonstration models in 1 town instead of having 20 towns with one pump! With a high concentration of pumps in a small area, people in that area will easily adopt the pump if it works fine. They see the pump at the house of neighbors, family, friends, etc. From there information will spread easily through the region when people are traveling.

Another good way to let people try the pump is putting out demonstration models when people are interested. The users can use the pump for a period of one month before they take the decision whether they buy the pump or not. When they buy the pump, users can pay directly or monthly in 6 or 12 terms (if the workshop can handle it. The pump can be seen as a guarantee, if people stop their payment the workshop can remove the pump).

MODULE 2: PRODUCTION OF THE ROPE PUMP



AH Model

&

AB Model

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2.1 Introduction

This production module gives a brief description of the parts of the Rope pump and leads for their construction and the use of welding jigs. Frequently made mistakes are noted as **Tip!**

Most important part and basis of this module are the technical drawings. These AutoCAD drawings consist of a scale and exact dimensions. It is advised to plasticize the drawings together with this module as part of a technical handbook, for reference during the construction of the Rope pump.

This module is inextricably linked to the following annexes:

- Annex II, A: Workshop equipment
- Annex II, B: Technical (AutoCAD) drawings
- Annex II, C: Material lists

Numbering of the parts

In the technical drawings all parts are numbered. The position of the different parts can be found in the technical assembly drawings. Almost all of the parts, for both the AH- and AB-model, are similar. Only the part numbers with different dimensions for both models are marked with a 'H' (hand dug well model) or 'B' (borehole model). For example, part number 9 is 'the structure'. The structure drawing for the AH model will be numbered '9H' and for the AB model '9B'. The different paragraphs in 2.2 will refer by number to the technical drawings.

Modifications

The pump dimensions and parts as described in this manual are defined by the publication date of the manual. In future new developments or experiences might bring slight changes in dimension or materials.

All eventual forthcoming versions will be documented in separate drawings with a new date and modification letter.

2.2 Leads in construction

2.2.1 Standardization and welding jigs

When starting Rope pump production it is strongly recommended to produce welding jigs. Although dimensions in the drawings are standardized, in practice, critical parts like the structure or the bushings mostly end up having different dimensions if welding jigs are not used. This is partly due to expanding and shrinking of the metal during the welding process. These small variations however, can have a large influence on the functioning and life time of the pump.

But there are more reasons to standardize the Rope pump production. By using welding jigs, all pumps and parts will be identical. The advantage of this shows itself in future. When, for example, the bushings of a three year old pump break down, they can easily be replaced by new ones from the workshop, without replacing the whole pump. Because of the standardization the new bushings will easily fit the old pump.

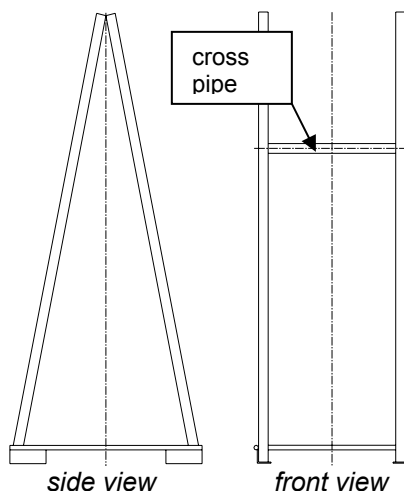
Also constructing concrete well covers or, in case of a borehole a concrete slab (which is mostly carried out by other persons), will be easy, ones the base of all pumps have the same dimensions.

For mass production, using the welding jigs, all parts can be constructed separately. However, when constructing a Rope pump, the most logical way to produce the different parts, is in the following order (in order of assembly):

2.2.2 The structure (part nr. 9)



structure in jig 1



side view

front view



welding jig 1



welding jig 2

Brief description

The structure consists of GI pipes, angle iron and reinforcement bar. These materials are thin and sensitive to deformation during welding. It is important that 'top' (for assembly of the bushings) and 'bottom' (for construction on slab or well cover) of the structure remain straight.

Welding jigs

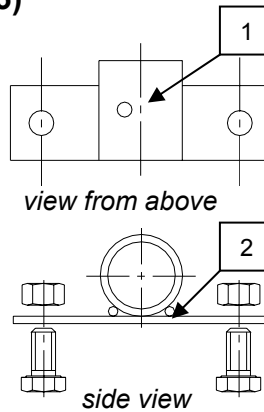
To prevent deformation of the structure there are two welding jigs. Jig 1 is designed for both sides (side view) of the structure. After construction, both sides can be placed in jig 2 and put together by welding the 'cross pipe'.

Tip! When welding this cross pipe, make short welds at the time to prevent deforming.

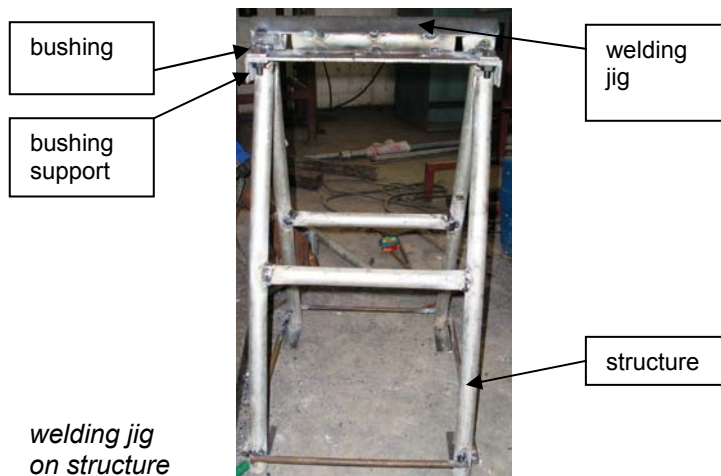
2.2.3 The bushing (part nr. 15)



bushing



welding jig, bushings



welding jig
on structure

Welding jig

For in-line construction of the bushing support (angle iron, constructed on top of the structure) and bushings, a welding jig is designed.

Put the GI pipe and the iron strip (bushing) in the jig. Put the angle iron beneath the welding jig and fix the iron strip, jig and angle iron together using bolts and nuts. Then put the jig on the structure. Weld the angle iron to the structure and construct the bushing (weld the GI pipe to the iron strip). Let the welds cool down before removing the jig.

Brief description

The bushing consists of 1" GI pipe and iron strip. The GI pipe serves as the bushing and supports the axle. The bushing is lubricated by use of a lubrication hole (1).

Tip!

To prevent wear on both, axle and bushing, the sharp edges, seam and burr have to be filed out until the inside and edge of the bushing show a smooth surface.

Tip!

The bushing has to fit exactly around the axle (max. 0.5 mm space). Therefore a wall thickness of 3 to 3.5 mm (GI pipe) is needed. A wall thickness of 2.5 mm creates too much space, the oil film tends to break and both, the bushing and the axle, will wear out faster.

Tip!

It is very important that the bushings on both sides of the structure are fixed exactly in-line. If not, the edges of the bushings will cut into the axle, finally resulting in a broken axle. Therefore the use of a welding jig is recommended.

Tip!

When welding the GI pipe to the iron strip, add a 6 mm round-bar (2) along the side of the pipe to create more welding space. Make short welds at the time to prevent deforming.

2.2.4 The wheel (part nr. 2)



compass



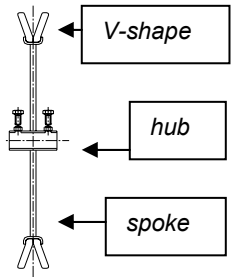
cutting the tire



measuring a spoke



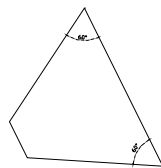
hub



welding jig



measuring angle with an equilateral triangle



Brief description

The most important part of the wheel is the 'V-shaped rubber, created by the two rims of a 14" car tire which are kept together by clamps.

Tip!

To create a sharp cutting line a compass can be made of reinforcement bar. The car tire can afterwards be cut with a sharp knife.

Tip!

Weld the spokes square to the clamps and paint the clamps before welding the spokes onto the hub.

Tip!

Drill holes in the hub and weld the nuts onto the hub. To prevent deforming, keep the bolt in the nut during welding. Protect the thread of the bolt with grease. Use rust-resistant bolt & nuts.

Welding jig

The welding jig consists of a 3/4" GI pipe and six arms (60° apart) welded onto a sturdy base.

Tip!

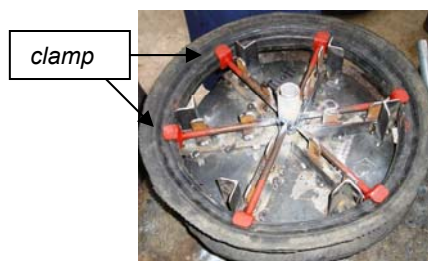
Put the tires and the hub on the jig. Put two opposite spokes in the jig at the time, square to the hub and weld. Continue with the next 2 spokes opposite each other.

Tip!

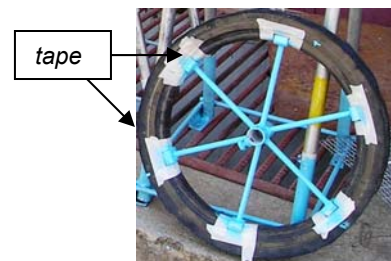
Tag weld the spokes only in the 60° corners. When the wheel is out of the jig, weld both sides 'in the length' of the hub at once, to prevent buckling during welding. When a jig is not used, make an equilateral triangle to measure the 60° corners of the spokes.



measuring in jig

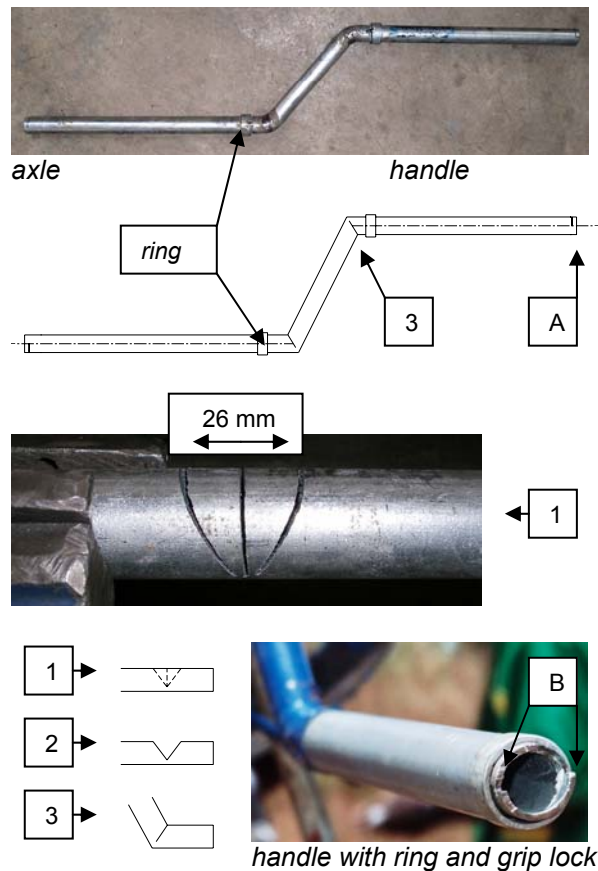


wheel in jig



painted wheel

2.2.5 The axle and handle (part nr. 16)



Brief description

The axle/handle consists of a $\frac{3}{4}$ " GI pipe, rings of 1" GI pipe and a pvc pipe.

Tip!

The axle is, together with the bushings, the most critical part of the pump. The axle is liable to irregular forces created by different users. Therefore a wall thickness of 3 to 3.5 mm is essential.

!! 'Cheaper' GI pipes (wall thickness 2.5 mm or less) will break within months of operation.

Tip!

For construction of the grip lock:

- A. Cut $\frac{1}{4}$ of the pipe at 5 mm distance from the end. Make a 5 mm squared cut to the end of the previous cut.
- B. Bend out the 'loose end' of the, created by the cuts.

Rule of thumb for handle

The handle radius (eccentricity) depends on the wheel diameter and calculated according following rule: **Handle radius = $\frac{1}{2}$ wheel inner diameter + 1 inch**

Example: If a 14" car tire is used the handle radius should be $(14/2 + 1 = 7+1) = 8"$.

Tip!

The best and strongest way to create the 'bend' in the axle, without deforming the pipe on the spot of the bushing, is to cut, bend and weld.

1. Make a straight cut into the GI pipe ($\frac{3}{4}$ of the pipe diameter). Make, 13 mm left and right of this cut (=26 mm apart), sloping cuts to the end of the previous cut.
2. Remove material.
3. Bend and weld the cuts together.

2.2.6 Pump lock (part nr. 17)



pump lock 'open'

'closed'

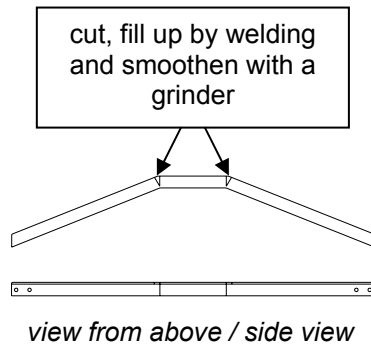
The pump lock avoids the handle from turning back when pumping is stopped and the handle is released. The lock is welded awry on the structure which enables the lock to fall open by gravity when pumping is resumed.

!! If the lock is not used the handle will turn back rapidly which is dangerous for children and can cause damage.

2.2.7 Cover support (part nr. 3)



cover support on structure



view from above / side view

Brief description

The cover support is welded onto the bushing support on the structure.

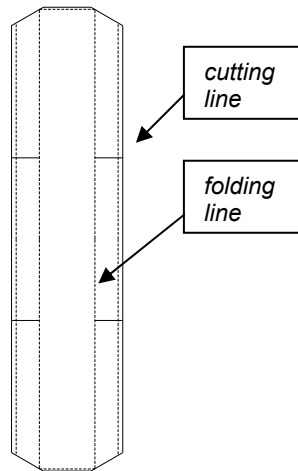
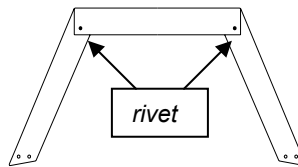
Tip!

To bend the cover support: cut, fill up by welding and smoothen with a grinder.

2.2.8 Pump cover (part nr. 1)



pump cover



Brief description

The pump cover consists of 0.6 – 1 mm GI sheet- metal.

Tip!

Before cutting, always calculate the most effective lay-out of the obtained sheet metal (use a model).

Tip!

Draw cutting lines and cut, draw folding lines and fold and measure on the cover support the position of the holes to be drilled.

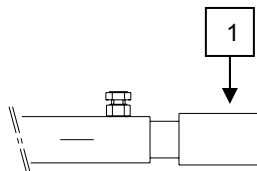


folding the pump cover

2.2.9 Rising main support (part nr. 5)



riser pipe support on structure



The size of the GI pipe (1) depends on the size of the rising main and is therefore exchangeable.
Please see module 3, paragraph 3.2.2

Brief description

The rising main support holds the rising main and prevents this pipe from falling, bending and vibration.

Tip!

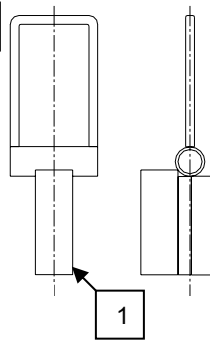
Keep the bolt in the nut when welding the nut to the support. Protect the thread of the bolt with grease.

!! Use rust-resistant bolt and nuts.

2.2.10 Guide box (part nr. 14)



different size guide box/riser pipe sup.



Brief description

The rising main support holds the rising main and prevents this pipe from falling, bending and vibration.

Tip!

Keep the bolt in the nut when welding the nut to the support. Protect the thread of the bolt with grease.

!! Use rust-resistant bolt and nuts.

2.2.11 Painting



painting anti-rust



final painted parts



final painted pump

To avoid corrosion, it is essential to paint the parts that have not been galvanized or where galvanization is damaged.

Tip!

It's recommended to paint at early morning or late afternoon when the temperatures of steel objects are cooler (less than 25°C). Steel temperatures during day time easily reach 32 - 38°C in the shade. Newly painted objects should be kept in the shade until they are dry, as steel temperatures easily rise up to 60°C when exposed directly to full sunlight. Paint should not be diluted unless it's old and too thick to paint with. If dilution is needed, use only special paint diluter and nothing else (no fuel!).

Painting of the pumps should be carried out in the following three steps:

- I. Remove all welding slack and visible grease with solvent, remove rust and treat all parts to be painted with sandpaper. Make sure that hands are free of grease.
- II. Paint all parts with antirust (anticorrosive primer). Be sure that welds are painted well. Let painted objects dry in the shade, NOT in the sun (when dried in the sun, blisters are a result and paint will come off shortly).
- III. When the antirust is completely dry (make sure hands are free of grease when moving the object), paint the structure with the final paint. Again allow painted objects to dry in the shade, NOT in the sun.

2.2.12 Serial number



example of a serial nr.

To be able to 'track' the pump and monitor its quality, it is advised to add a unique serial number and workshop initials to each produced pump. This serial number will refer to the log-book of the workshop.

This record will hold the following information:

- Serial number
- Production, Selling and Installation date
- Name of the buyer and place of installation
- Model and selling price

2.2.13 Measurements



worthless tri-squares

Correct measurements are the key for the production of a good working Rope pump.

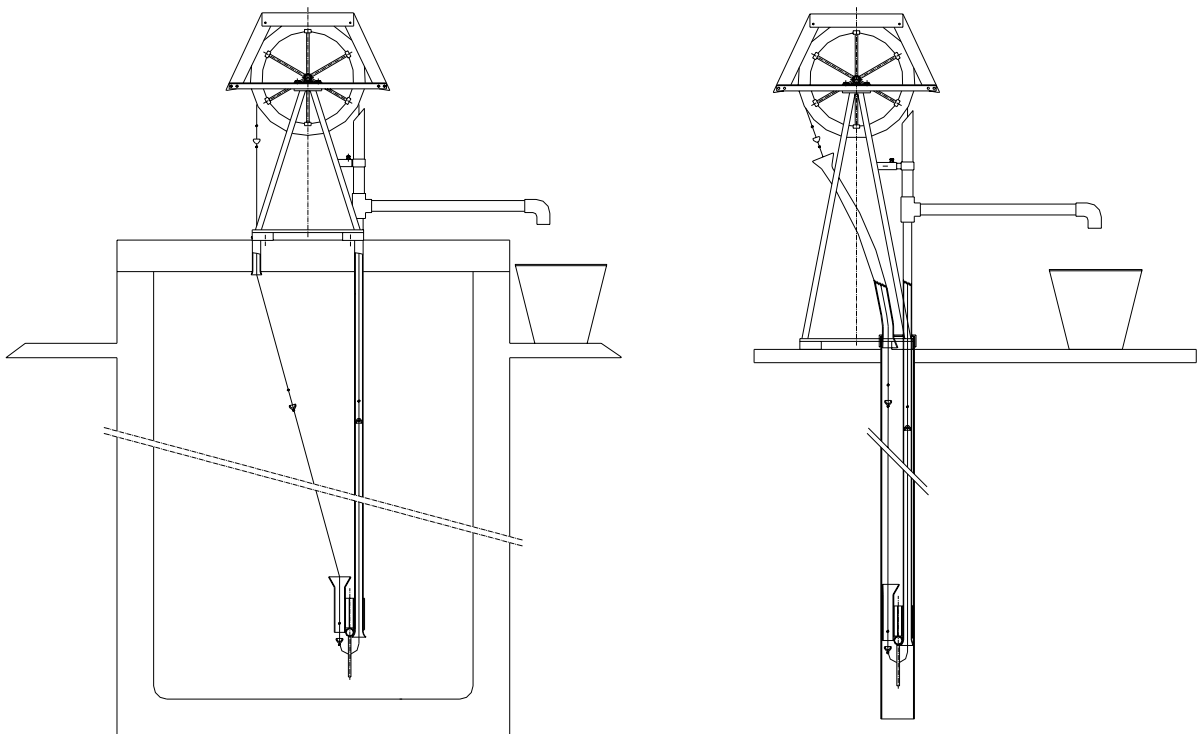
Tip!

Use measuring instruments only for measuring!

Tri-squares for example, are designed to measure a squared (90°) angle, but are often misused to remove welding slack. Doing so will make the tri-square useless for measurement.

See photo: these tri-squares were misused to remove welding slack. None of these tri-squares still showed a 90° angle!

MODULE 3: INSTALLATION



AH Model

&

AB Model

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3.1 General aspects

The installation module will describe the position and installation of the Rope pump on hand dug wells and boreholes. Subjects are ergonomics and hygiene (background information) and a step by step description of a decent installation. Frequently made mistakes are noted as **Tip!** in each paragraph.

3.1.1 Ergonomics

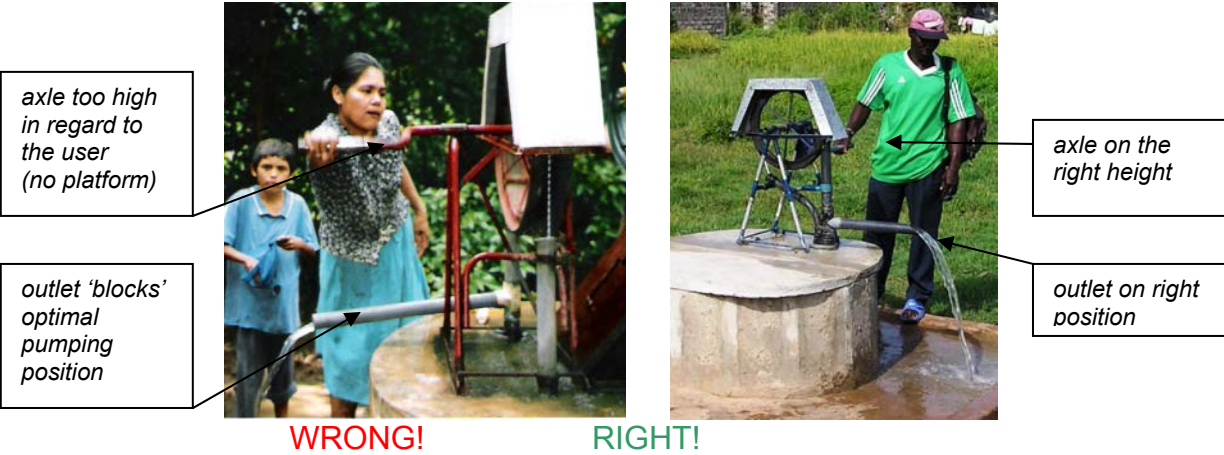
The major difference between the AB, and the AH model is the length of the frame. The most ergonomic pose and the strength of the arm muscles and are optimal when the axle of the pump is situated at elbow (belly button) height.

The center of the axle should be at belly button height of the average user

The top of most existing hand dug wells is constructed high, while most of the borehole casings (tube wells) are cut off just above the ground. Therefore the length of the structure part is different for both models.

In many cases hand dug wells are high. This might require a concrete platform in front of the pump, for the users (take the average user) to reach the optimal pumping position.

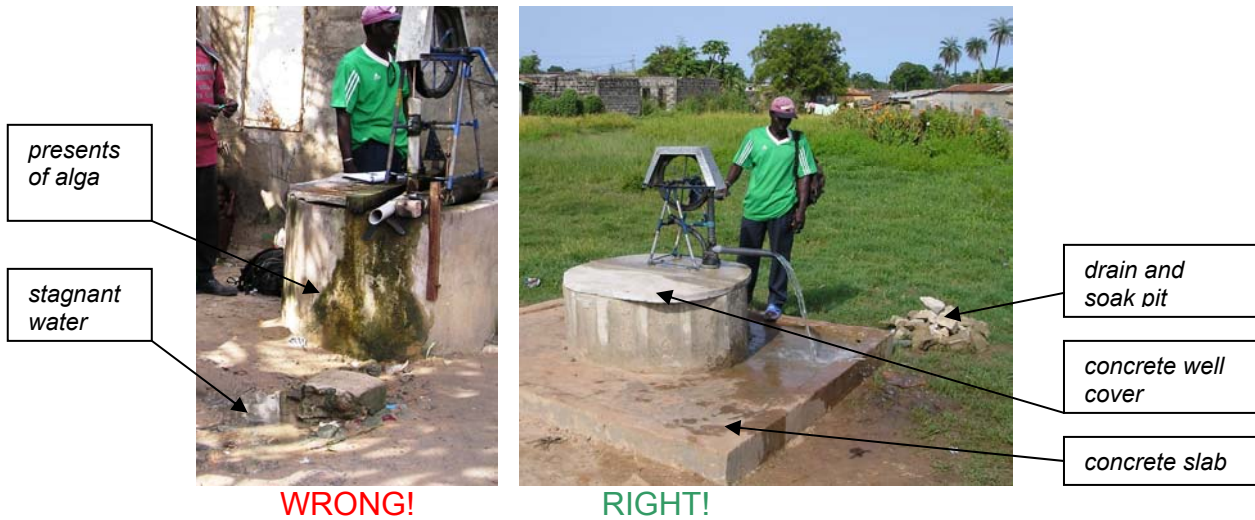
Tip!
Make sure the concrete platform is made and completed before or during the installation, experiences indicate that: **afterwards this will be 'forgotten'!**



3.1.2 Hygiene

Hygiene is often an underestimated problem. Especially in hot climate, stagnant water in the well surroundings will become a breeding place for bacteria, algae and mosquitoes. Contamination and dirt from the street and latrines are carried to the well unnoticed by feet of the users and can sometimes multiply rapidly in the wet well surroundings.

This stagnant water, rich of bacteria and other contamination, is a big thread to the well water as it penetrates the soil and groundwater near the well. Wet well surroundings are always contaminated and the presents of algae indicate that this wet environment doesn't dry up. Therefore stagnant water should be avoided.



Concrete slab

A good way to prevent infiltration of contaminated water near the well is a concrete slab. The concrete slab consists of a raised border preventing the water to flow off. The slab runs in an inclined plane to the drainpipe.

Drain and soak pit

The drainpipe will carry the water away from the well, preferable 5 meter or more (in the picture this is only 2 meters), where it will infiltrate into the so called 'soak pit'. The soak pit is nothing more than a dug out hole, filed with stones, to capture the water and provide time for the water to infiltrate the soil. The water will be carried away quickly from the slab. Once the water is infiltrated it will be filtered by at least 5 meters of soil, before returning into the well.

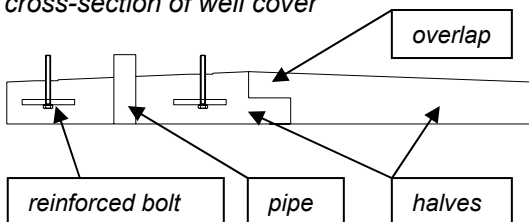
Concrete well cover



debris found in 10 hand dug wells

!! As this picture shows, often a lot of 'debris' enters the well from above. Not only debris, but also mosquitoes and bacteria will enter the well this way. Also the Rope pump parts in the well are very sensitive to debris. Therefore the use of a concrete well cover is strongly recommended. It is also safer and prevents children from falling in.

cross-section of well cover



Construct the well cover in two halves. These are easier to carry and essential during Rope pump installation! The cover parts run in an inclined plane and the overlap prevents water from entering. The bolts and pump pipes are integrated in the concrete.

Tip!

Make a mould for constructing the well cover. Also make a jig to position the bolts and pump pipes in one of the halves and reinforce the well cover with reinforcement bars. The well cover should be at least 8 cm thick. The border, which runs around on the bottom of the cover, will prevent water and dirt from entering the sides.

3.2 Pipes and pistons

3.2.1 How it works

The Rope pump consists of a wheel and an endless rope with small pistons, made of polyethylene (or car tire in home made models) which are attached to the rope at intervals of 1 meter. The pistons fit, with a clearance of around 1 mm, in the PVC pipe called 'rising main'. The rope and pistons move freely (no pipe) down into the well. At the bottom, the rope is led by a guide box into the rising main. The rope and pistons are lifted by the wheel. The weight of the water column forces the rope further into the V-shaped wheel, creating more resistance between the wheel and the rope. This prevents the rope from slipping. (It's therefore that U-shaped concrete wheels don't work). The water is brought up by the pistons and discharged at the surface.

3.2.2 Static head

The size of the PVC rising main depends on the static head. The static head is the water column which has to be pumped up. This water column is the entire distance between the water level in the well (draw down water level in bore holes) and the point where the water is discharged at the surface.

Remember!

The size of the PVC rising main depends on the depth of the water level in the well and NOT on the total depth of the well.

Why different sizes?

The water column is brought up by the rope and pistons driven by the wheel, which is powered by the user. If the water level in the well is high, the relative weight of the water column is low. The wheel is easily turned around by the user. If the water level in the well is low, the relative weight of the entire water column is high and therefore very heavy. In this case it would be difficult for the user to turn the wheel. To reduce the weight of the water column at greater depths, smaller PVC rising mains are used.

Example

For example, a 30 mm PVC pipe contains around 700 ml of water per meter (0.7kg). If this pipe is used in a well with a water level on 10 meters, the total weight of the water column will be: $10 \times 0.7 \text{ kg} = 7 \text{ kg}$. This weight can be lifted easily by the user.

If the water level would be at 30 meter, the total weight of the column would be: $30 \times 0.7 \text{ kg} = 21 \text{ kg}$. This is too heavy for the average user of the pump (mainly woman and children). Therefore the weight of the water column has to be reduced.

To overcome this problem a smaller diameter rising main is used. For example, an 18 mm PVC pipe contains 250 ml of water per meter (0.25kg). Using this pipe in combination with water level of 30 meters the total weight of the water column will be: $30 \times 0.25 = 7.5 \text{ kg}$. Again this can easily be lifted by the users.

Size of the rising main

| Static head (meter) | PVC inner diameter* (mm) | PVC outer diameter* (mm) |
|---------------------|-----------------------------|-----------------------------|
| 0 – 5 | 38 | 42 |
| 5 – 10 | 30.3 | 33.3 |
| 10 – 20 | 23.3 | 26.8 |
| 20 – 35 | 17.8 | 21.5 |

!! * PVC inner and outer diameters are different from country to country and even, despite standardization, from factory to factory. The diameters in this table are therefore indicative numbers.

3.2.3 PVC parts

Rising main

Often an inventory of available PVC pipes and pieces show that different 'standards' are used by different PVC factories and imported PVC pipes. PVC pipes of different origin are often slightly different in size. The main problem is that 'the same looking' and coded pipes, reducers and T-pieces produced in one factory, not always fit pipes of other factories.

!! Combining pipes from different origin (factories) will result in:

- either breaking or disconnection of riser pipe, reducer and T-piece or;
- too much or too less clearance between the (standard size) PE pistons (see paragraph 3.2.4) and the riser main resulting in flow loss or pistons which get stuck in the riser main.

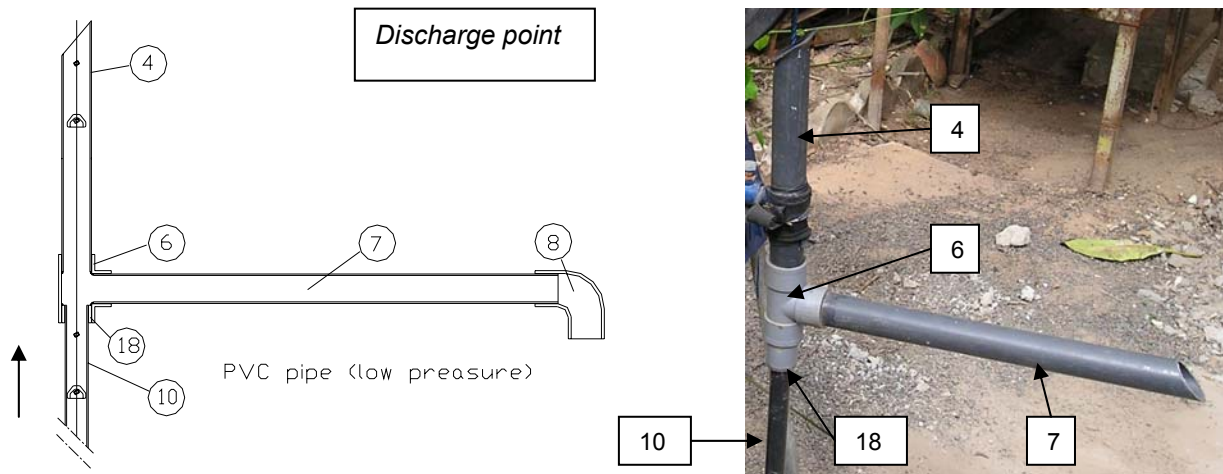
Tip!

It is advised to determine the most commonly available sizes of, the low pressure type, PVC pipes, at all places where pumps will be produced. As a result of this inventory the most commonly available pipe (and thus the measured inner diameters of the 4 sizes) can be set as a standard for future piston production.

It is recommended to use 'low pressure type' pipes because 'pressure type' (thick wall) pipes are more expensive and the smaller inner diameter result in a lower flow rate. These 'low pressure' pipes have, on average a wall thickness of 1.5 – 2.5 mm.

Discharge point

The water is lifted by the rope and pistons which fit, with a clearance of 1 mm, in the riser main (nr 10). The riser main ends in a 'reducer' (nr 18), increasing the inner diameter with one or two 'pipe sizes'. The 'reducer' fits into the bigger T-piece (nr 6), with the outlet (nr 7) and the top pipe (nr 4) attached to it. The water is carried up until the pistons arrive in the bigger top pipe (nr 4), where the water can easily pass between the pistons and the pipe wall. The water is discharged through the outlet (nr 7). To point the water flow in direction of the jar or bucket an elbow (nr 8) can be attached.



Pistons

Pistons can be made out of Poly Ethylene or rubber. It is recommended to use and produce the triangular shaped Poly Ethylene (PE) pistons. As the Rope pump will be used for potable water, PE pistons are cleaner and will be easier accepted by government, NGO's and donors (in terms of hygiene) and will give less friction in the pipes during operation of the pump, making it more attractive for users.

Pistons should be made out of Poly Ethylene (PE) plastic. Other plastics will either break or deform during operation! PE can be obtained as pellets (imported by the factory) or from recycled plastic. Pistons should be produced with a clearance between 0.5 and 1 mm on both sides between piston and pipe.

Tip!

After the standardization of PVC pipes and PE pistons, the pistons can be put on a chain (like a key-fob) and be used as a tool to check the right size when PVC pipes are obtained.



PE pistons



PE piston mould and extruder



Rubber pistons made of car tire

3.3 Preparations

3.3.1 Rope and pistons

Ropes made of Poly Propylene (PP) give the best results. These ropes don't slip and don't stretch too much. The alternative is a rope made of Nylon, but these ropes tend to slip and stretch! The rope diameter should be 6 mm.

Rope length: twice the depth of the well, + 2 meters, + 5% (for the knots)

The pistons are thread on the rope and positioned in between two knots, which are roughly 8 cm apart. The distance between two pistons is 1 meter! (not closer, because more pistons on the rope will create slipping between the pistons and the wheel).

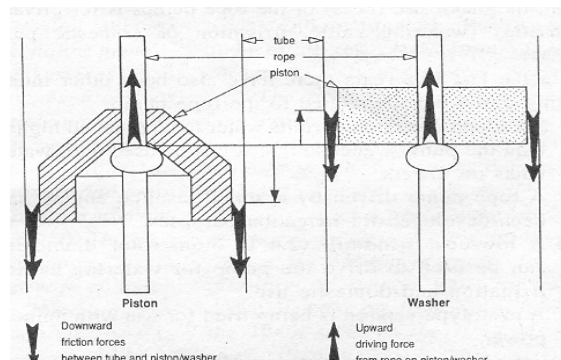
- When threading the pistons to the rope, be sure your hands are clean. Don't put the rope on a dirty surface as it will be used for drinking water purposes!
- All pistons should point in the same direction



PE piston on the rope

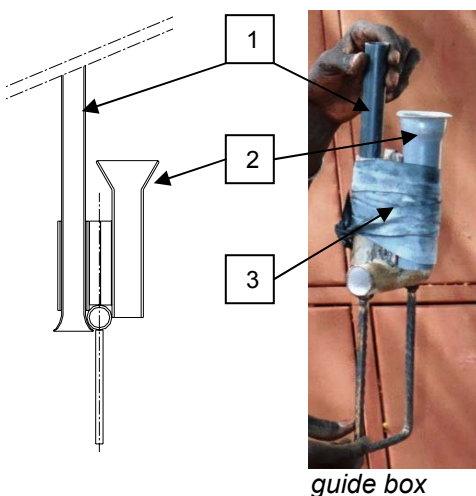


rubber piston on the rope



The PE piston centres itself in the tube, due to its shape, which is less the case for a rubber piston.

3.3.2 Guide box (part nr. 13 and 14)



guide box

Brief description

The guide box will guide the rope and pistons into the rising main at the bottom of the well.

The rope and pistons move freely (no pipe) down into the well and are collected by a flared 'catcher' pipe (2).

The rope and pistons are then guided into the rising main (1).

The catcher pipe (2) is easily attached to the guide box by a strip of inner car tube (3).

3.4 Installation

3.4.1 Materials

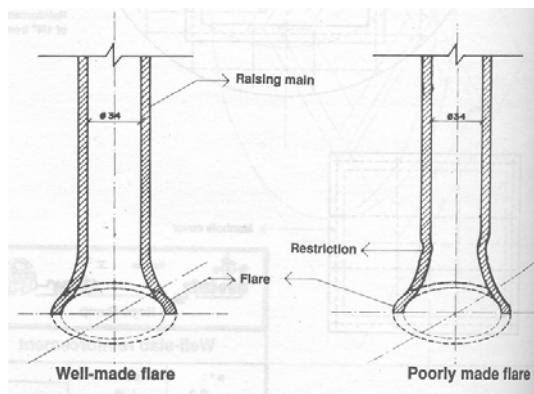
Before going into the field, especially in rural areas, check all tools and materials needed for installation! (Please find a list of needed tools and materials in Annex III)
A good indication on the water level in the well is essential to purchase the PVC parts (please see paragraph 3.2.2 and 3.2.3).

At least two people, preferably the new owner and/or some of the users are needed for installation. Also there need to be a sufficient amount of people to lift the well cover halves, in situations where the rope pump is placed on a hand dug well.

Before installation, measure the water level and the total depth of the well.

3.4.2 Making Flares

Flares have to be made on those ends of the PVC pipe, where rope and pistons enter:
- On the guide box: rising main and catcher pipe.
- On top of the well: place where rope and pistons enter the well through the well cover.



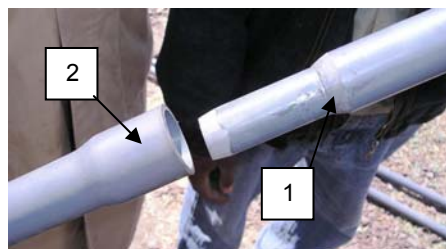
The flare is made by heating the end of the pipe and then opening it up with a flaring tool (for example a V-shaped stick or soft drink bottle).

Tip!

Don't heat up the pipe-end too much! This will create restrictions which hamper the entry of the pistons.

3.4.3 Connecting pipes

To connect the PVC pipes of the rising main a socket has to be created. To make a centralized socket, a simple tool (1) can be made out of two pipes; one which fits the inside diameter of the rising main and one which is equal to the rising main.



constructing a socket

Tip!

Heat up the end of the rising main.
Insert the tool (1).
Cool the end of the rising main with water (turn the tool around to prevent it from getting stuck).
Remove the tool out of the rising pipe.
The socket is created (2).

Roughen up the inside of the female (1) and the outside of the male (2) part with sandpaper.



glue the pipes together

Tip!

When glue the pipes together, only glue the male (2) part. NOT the inside of the female (1) part. If you do so, the male part will push the glue inside the female part forward, creating a rim on the inside, which could block the pistons.

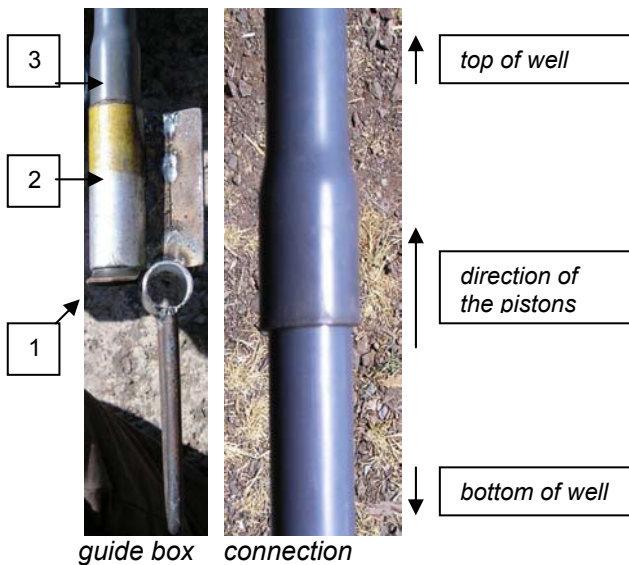
3.4.4 Installation step by step

Step 1

Measure the depth of the well. Glue the riser main together. During installation the length of the riser main will be:

- Total depth of the well (bottom – base of rope pump) + 1 meter.

Step 2



Take a short piece of riser main and make a flare (1). Insert the flare into the GI pipe (2). Glue a female part of the riser pipe on top (3).

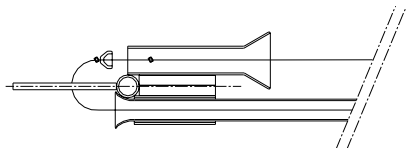
Tip!
Make sure during installation all connections are constructed with the male parts towards the bottom side of the well and the female parts towards the top side of the well.

In this way the up moving pistons will not get stuck behind the male the end of the male (rim) inside the pipe.

Step 3

Pull the rope with pistons through the pipe.

!! make sure PE pistons will move in the right direction.



guide box with rope and pistons running through.

Tip!

To pull the rope through the pipe:

Take a thin rope and connect a heavy bolt to it. Drop the bolt and the rope through the pipe. Connect the rope with pistons on the thin rope and pull it through.

Connect both ends of the rope temporarily together on the top end of the riser main to prevent the rope from dropping into the well during installation.

Step 4

Mark on the top end of the riser main on which side the catcher pipe of the guide box is situated. This is needed to get the guide box (at the bottom) and the pump (on top) properly aligned after installation.

!! If this is not carefully done, the rope and pistons might wind around the riser main and get stuck.

Step 5

Lower the guide box with rising main and rope into the well.



Installing the guide box with rising main and rope.

Tip!

The rising main should be lowered in a bend as large as possible, to prevent cracks or even breaking of the pipe.

Tip!

Don't turn the rising main around during installation to prevent the rope from winding around the rising main. Keep the rope on one side of the rising main.

Lower the guide box and rising main to the bottom of the well. Keep a clearance between the guide box and the bottom of the well to avoid sediment to be pumped.

For hand dug wells this clearance is 10 cm.

For tube wells this clearance is recommended to be at least 50 cm.

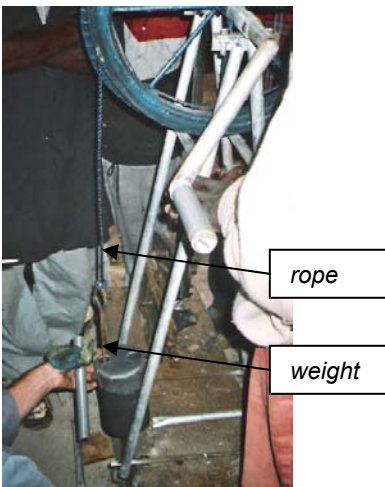
Step 6

When the guide box and rising main have reached the correct depth, the rising main has to be cut around 5 cm above the well cover. Especially in case of a tube well, make sure a can or bucket (to be filled with water) will fit under the outlet. If not, the rising main should be cut higher.

Tip!

While cutting the riser main, hold the rope on the opposite site of the cutting line. Make sure the rope is not cut or damaged!

Step 7



aligning the pump

When the pump is installed on a tube well, the pump (wheel) should be aligned with the rising main and/or the hole in the well cover for the rising main, before final installation.

Tip!

Put a plumb (rope and weight) over the wheel. The rope should be in the middle of the rising main.

When a concrete slab or concrete well cover with bolt connections for the pump is installed, alignment should take place during construction of the slab (to position the bolts in the concrete).

Step 8



connecting PVC parts together

Tip! Roughen up with sandpaper:

- The top outside of the riser main
- The inside of the reducer where the riser main enters.
- The outside of the reducer.
- All three insides of the T-piece.
- One side of the outlet.
- One side of the top pipe.

Glue all parts together.

Tip!

Make sure all parts fit each other exactly. Please see paragraph 3.2.3

Step 9



1. making a loop by threading the rope back



2. checking the tension

Take the rope between thumb and forefinger.

Turn your hand.

If the turn can be completed between 90 and 180 degrees, the rope tension is ok.



3. create the second loop



4. seaming the end of a nylon rope loop

Put the rope end coming out of the riser main, over the wheel.

1. Make a loop on one of the rope ends by threading the rope three times back, through its own base.
2. Put the other rope end through the loop and check the rope tension.
!! There should be little play on the rope. If not, the pistons get stuck in the guide box and the rope might slip on the wheel.
3. When the rope tension is ok, create a second loop with the other rope end.
4. If nylon rope is used instead of PP, it is recommended to seam the end of the loop to avoid disconnection of the loop (nylon tends to slip)

Tip!

Make sure the length of the full loop does not exceed 30 cm. As the loop consists of a double threaded rope, this part will not fit the V-shaped wheel very well. A long which is too long might slip on the wheel.

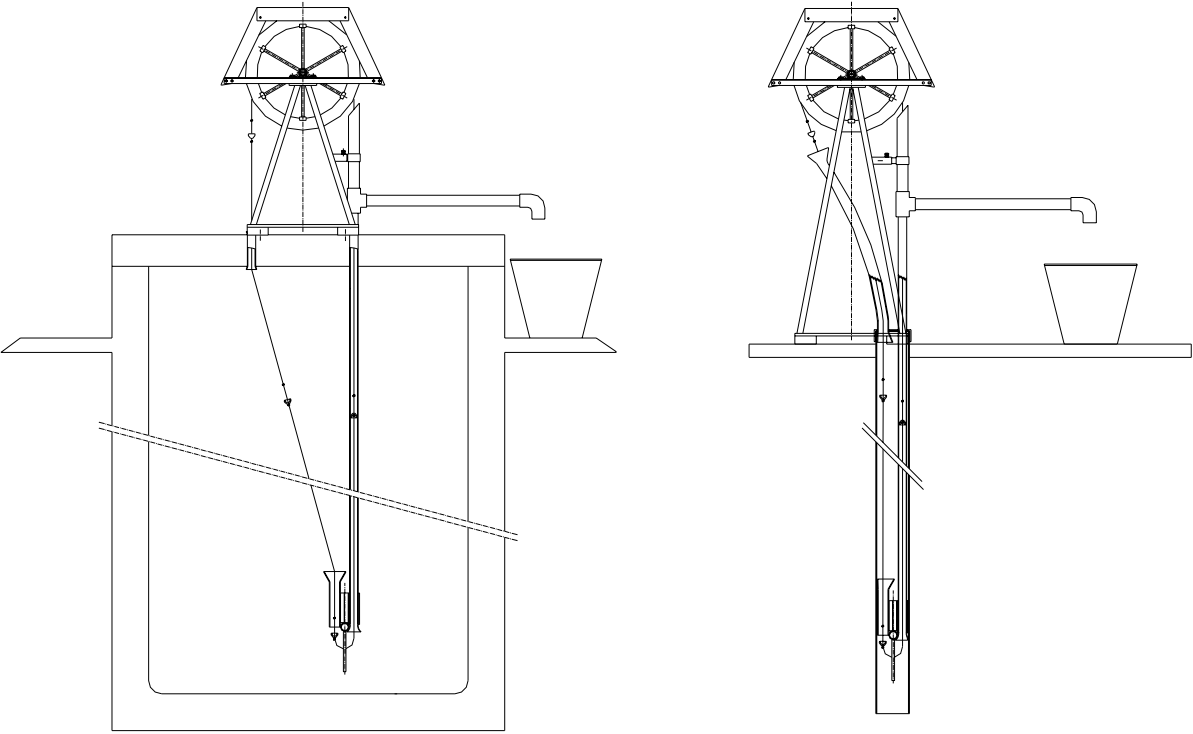
Tip!

Just after installation the rope tends to stretch a bit, making the rope longer. Check the rope tension again after the pump is tested. Make sure the users will check the tension periodically.

Step 10

When the pump is successfully installed, provide operation- and maintenance training to the users, using the operation- and maintenance sheet of module 4. After construction and installation be sure the pump is working fine before leaving the site, using the technical checklist (Please see Annex I).

MODULE 4:
OPERATION & MAINTENANCE



AH Model & *AB Model*

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4.1 Introduction

This operation- and maintenance module consists of two parts:

- A written description of the maintenance.
- An operation and maintenance sheet, which can be plasticized and distributed together with the pump, for the users. As the literacy rate amongst users might be low, the operation and maintenance sheet consists of photos and cartoons. All operation and maintenance activities can be carried out by the users themselves.

When the pump is successfully installed it is recommended to provide operation and maintenance training to the users of the pump, using the operation and maintenance sheet. In this way the users will get familiar with the subject. Don't use the rope pump on communal wells with more than 10 households (50 users). Operation and maintenance of the pump can not be carefully carried out when large groups are using the pump.

4.1.1 Operation

Functioning and life time of the pump will be increased when care is taken during operation of the pump.

Guidelines:

- Only rotate the pump clockwise, never turn the pump reverse direction.
- Always use the pumping lock when pumping is stopped.
- Don't let very small children operate the pump. If the handle slips out of their fingers, the pump will turn in backwards direction and the handle could hurt the children.
- Don't operate the pump with more than one person at the time. Avoid children hanging on the handle.

4.1.2 Regular maintenance

Regular maintenance is necessary to keep the pump in good shape and guarantee a long running time.

Tasks are:

- Checking the tension of the rope and adjusting when needed.

- Lubricating the bushings every 2 weeks or when the bushings are running dry.

If the bushings start to make a shrieking noise oiling is URGENTLY needed. Add a few drops of NEW motor oil. (In case motor oil is not available, cooking oil can be used for emergency)

Use a clean stick to apply the oil, NOT with your fingers and remember:

**USE ALWAYS NEW OIL, NEVER USE OLD (USED) OIL!
NO GOOD OIL = NO PUMP!**

Old oil contains iron particles and dirt, and will sand the inside of the bushings, reaching the opposite effect. Don't use too much oil at the time to prevent leaking into the well.

- Carry out repairs when needed.

4.1.3 Potential repairs

- *Replacement of the rope.*

Pistons usually last about twice as long as the rope. When the rope shows a lot of damage, the rope should be changed preferably before it breaks.

Tie the new rope (with the pistons) to the old rope (be sure pistons are running in the right direction) and pass it through the tubing. It is not necessary to take out the tubing.

- *Replacement of pistons*

The pistons should be changed, when the user has noted a reduction output.

Before changing the pistons, check the clearance in a piece of riser main to check whether a reduced output is due to worn-out pistons.

- *Painting*

To avoid corrosion, it is essential to paint parts again that start corroding.

Clean the parts with a steel brush and roughen it with sand paper.

Then apply anticorrosive primer paint, and when it's completely dry, finish it with paint. Allow the paint to dry in the shade, NOT in the sun.

- *The bushings*

If bushings are worn out , dismantle and replace them.

(If properly oiled, bushes last for 10 years or more!)

- *PVC tubing*

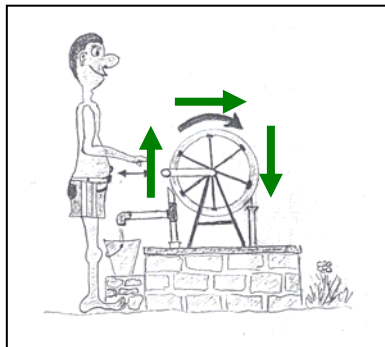
If a pump is placed in direct sunlight, the ultra-violet rays will affect the PVC parts, causing cracks. (To prolong life of PVC, paint it!)

If the well contains fine sand, the sand will wear out PVC parts as well. In case wear is excessive, replace tubing.

4.2 Operation- and Maintenance sheet



pump direction

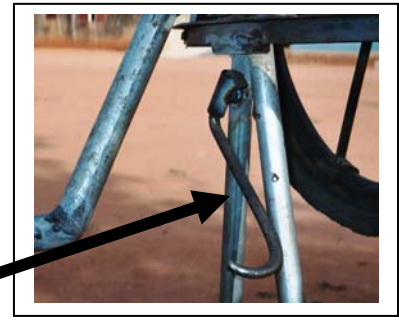


don't hang on the handle

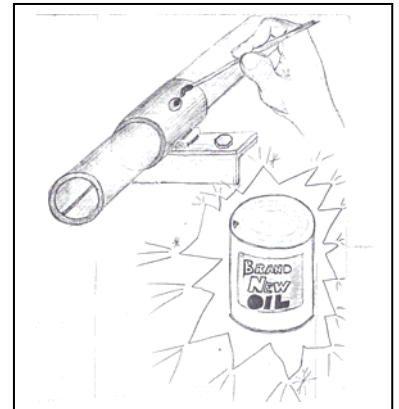


pump lock closed if not in use

pump lock open during operation



lubricate the bushings



check rope play



making a loop



the loop / seam end of the loop

Annexes

Annex I Module 1 and 3:
Rope pump technical checklist

Annex II Module 2:
A: Workshop equipment
B: Rope pump technical AutoCAD drawings
C: Material lists

Annex III Module 3:
Tools and materials for installation

Annex I

Rope pump Technical Checklist

Annex I

Rope pump technical checklist

Date of visit:
 Name technician:
 Pump number: nr..... ,produced by.....

User(s)

Name owner:
 Name of area:
 Number of users:
 Comments of users:

Pump

Installation date: ,installed by.....

Comments

Water level: dry / wet season
 Well depth:
 Well type: hand dug well / tube well
 Well cover: concrete / open / other:
 Piston size: PE / rubber **size:**
 Piston quality: OK / cracks / holes / all present /
 Rope quality: OK / warn out / broken /
 Rope tension: OK / loose / tight /
 Rope connection: OK /
 Grip on wheel: OK / slipping /

PVC

T-piece: OK / broken / clean / dirty /
 Reducer: OK / broken / clean / dirty /
 Riser main: OK / broken / clean / dirty /
 Flares: OK / broken / clean / dirty /

Structure

Welding: OK / broken /
 Painting: OK / come off /
 Rust: Yes / no / little / much **Place:**
 Axle: OK / damaged **Wall thickness:**
 Bushing: OK / damaged **Wall thickness:**
 Handle (grip): OK / PVC broken /
 Grip lock: wrong direction / right direction
 Height of handle: OK / too height / too low /
 Wheel: OK / damaged /

Pumping

Pumping: easy / difficult / resistance /
 Guide box: OK / clean / dirty / rusty /
 Water discharge: OK / very little / **Turbidity: high / low / clear**

Problems:

Actions taken:

Annex II

A Workshop equipment

B Rope pump technical AutoCAD drawings

C Material list

Annex II A

Workshop equipment needed

Machines:

- Electric welding machine, 220 V; 100 amp.
- Electric grinding machine, bench model
- Angle grinder
- Drilling machine, bench model
- Hand drilling machine

Tools:

- Hand pop riveter for 3 mm rivets, (incl. pop rivets)
- 2 Spanners 14 (For M10 bolts)
- 2 Hack saws plus 4 spare blades
- Sheet cutter for sheet up to 1 mm
- Strip cutter for strip up to 3 mm (optional)
- 2 Flat files
- 2 Round files
- 2 Pliers (incl. vice grip)
- Set drill bits 3 mm to 12 mm (spare bits of 3mm 6 mm and 11 mm)
- Steel brush
- Hammers (Normal, heavy and welding hammer)
- 2 Workbenches with vice
- Center punch

Other:

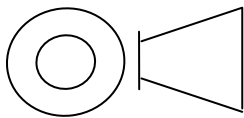
- Electrodes 2.5 mm
- Paint (anti corrosive + gloss)
- Sandpaper and paint brush
- Painting tape
- Lighter and wood or torch material
- Oil 10 W 40 (for bushings)
- Grease (to protect bolt threads during welding)

Measuring tools:

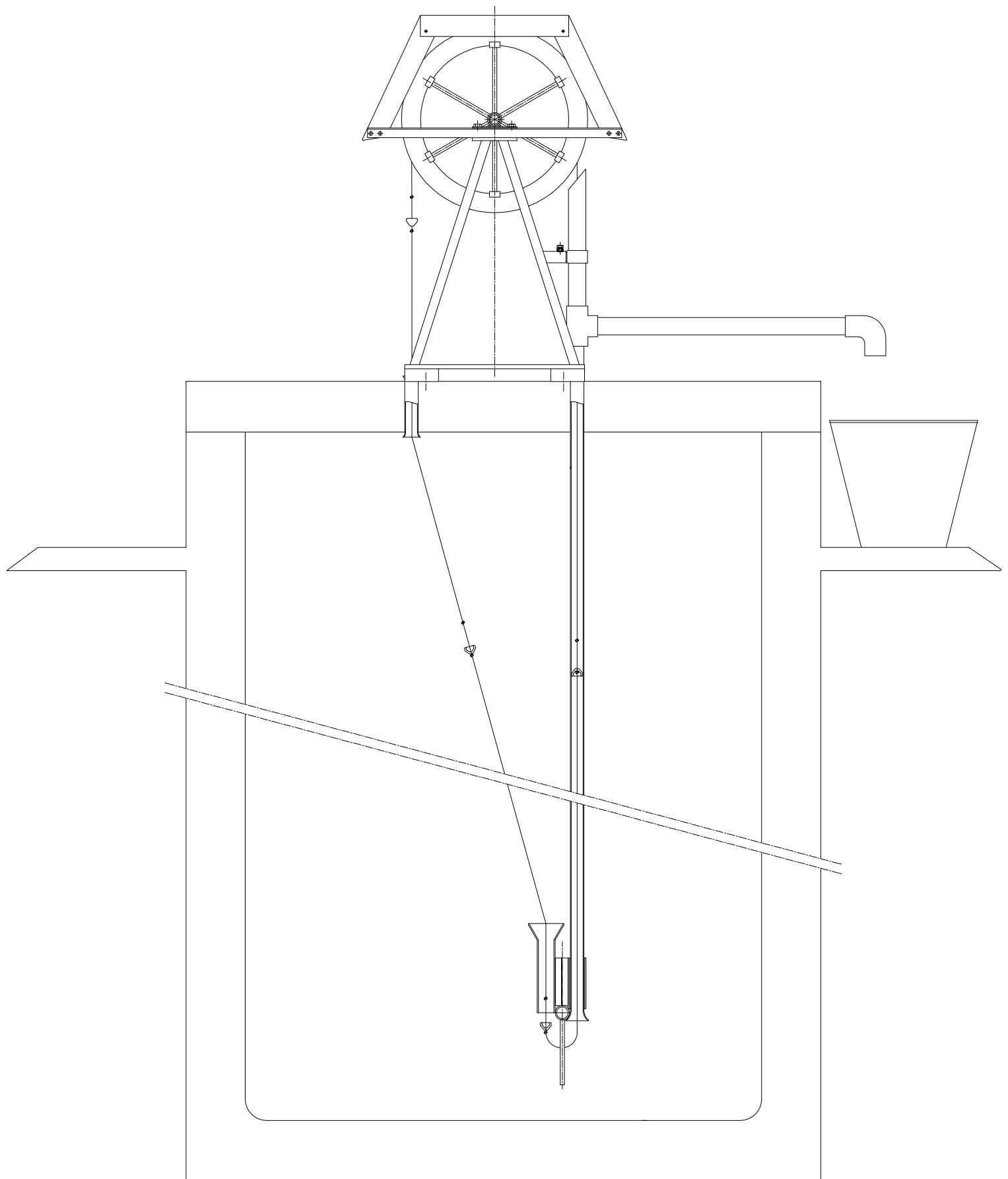
- Measuring tape
- Tri-square
- Rule
- Compass
- Scriber

Annex II B

Rope pump technical AutoCAD drawings

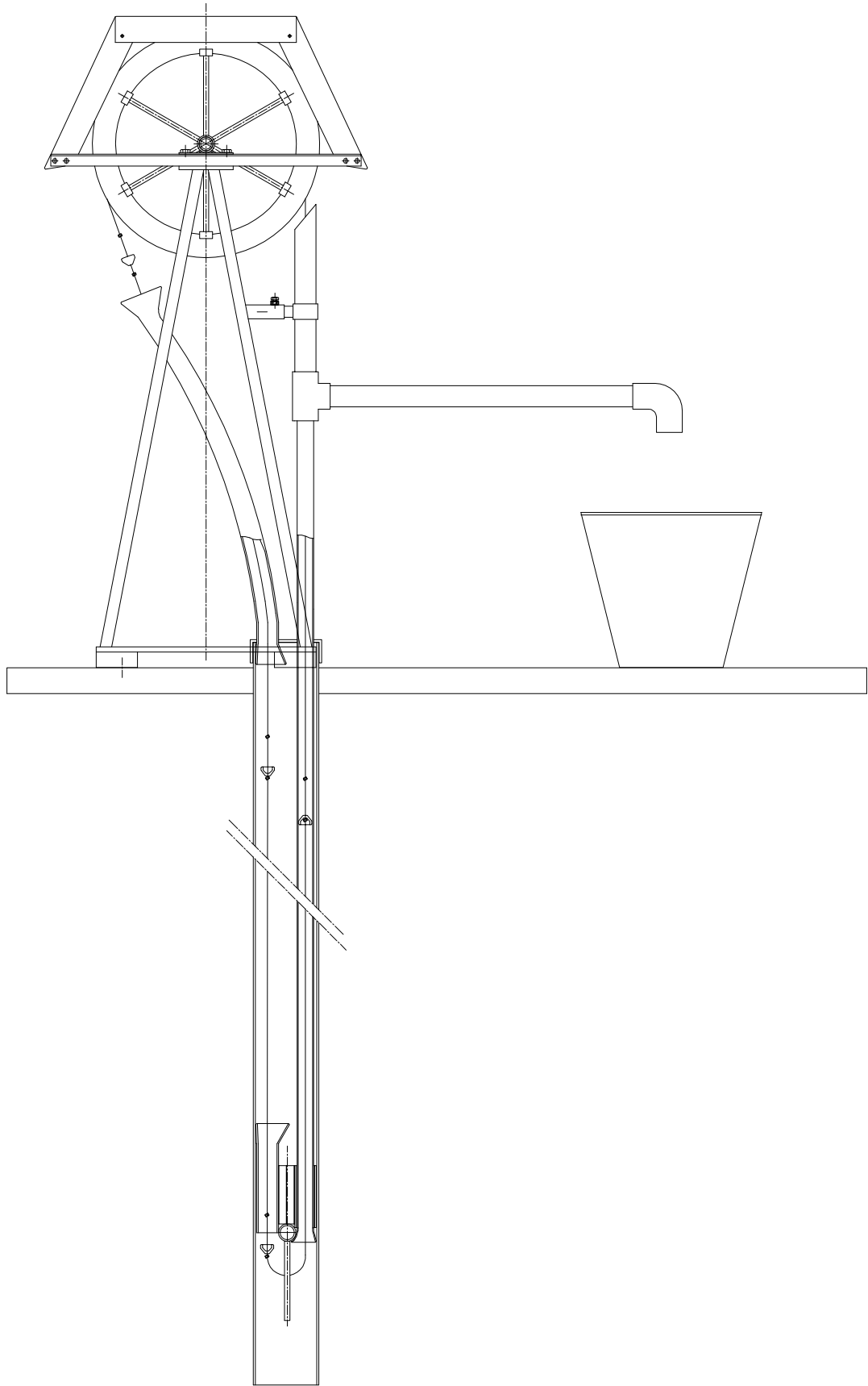


The dimensions used in the drawings are recommended. However, each country has developed its own standard based on the availability of materials. Slight differences in dimensions might appear, but if the essential parts are well constructed (i.e. wheel, handle and bushings well aligned), these differences will not influence the quality of the pumps.



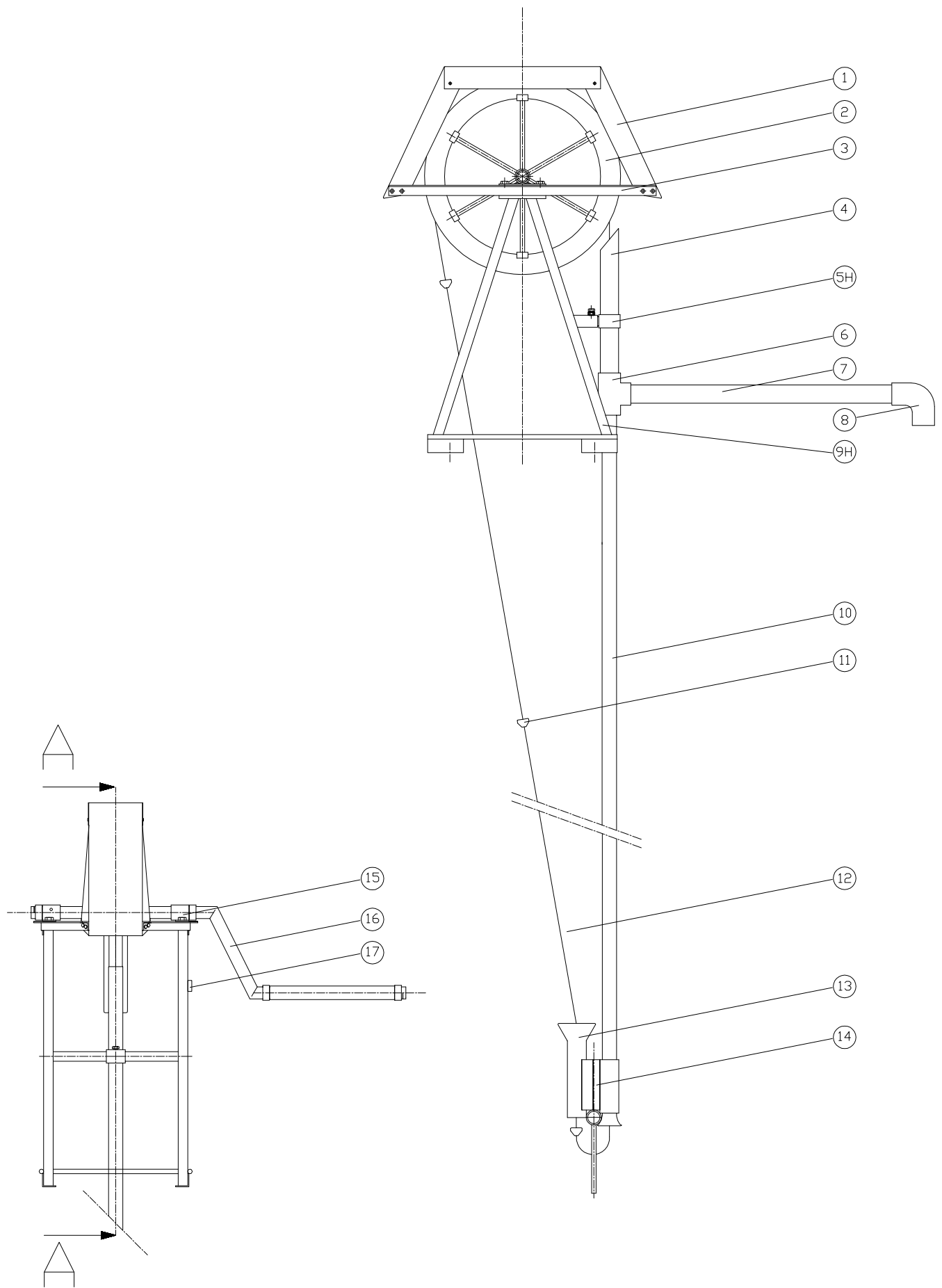
Rope pump Ethiopia AH 'hand dug well'

| Piece | Material | Scale | Date | |
|--------------|----------|-------|----------|----------|
| General view | | 1:12 | 18.03.06 | PRACTICA |



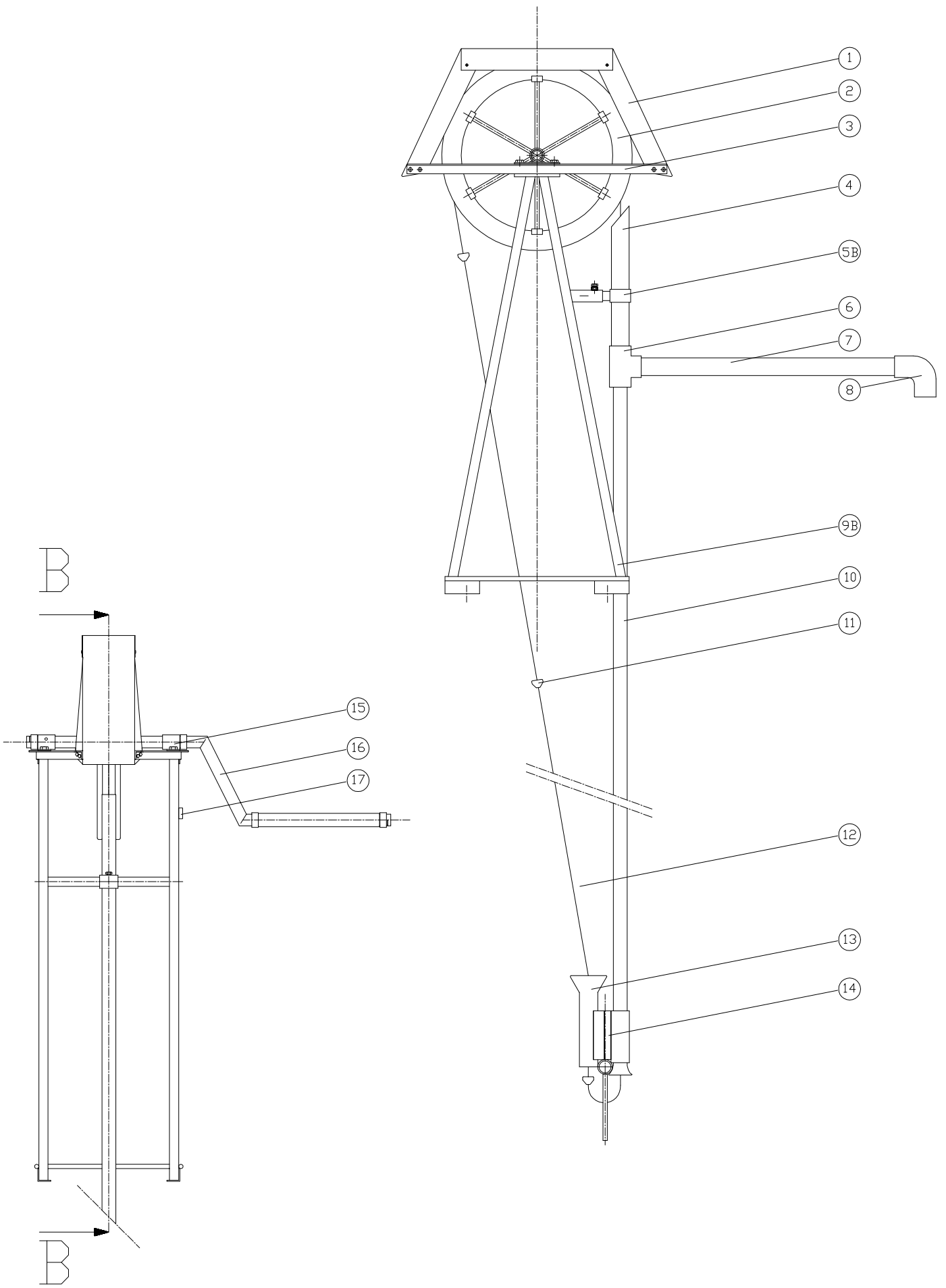
Rope pump Ethiopia AB 'borehole'

| Piece | Material | Scale | Date | |
|---------------|----------|-------|----------|----------|
| _General view | | 1:12 | 18.03.06 | PRACTICA |



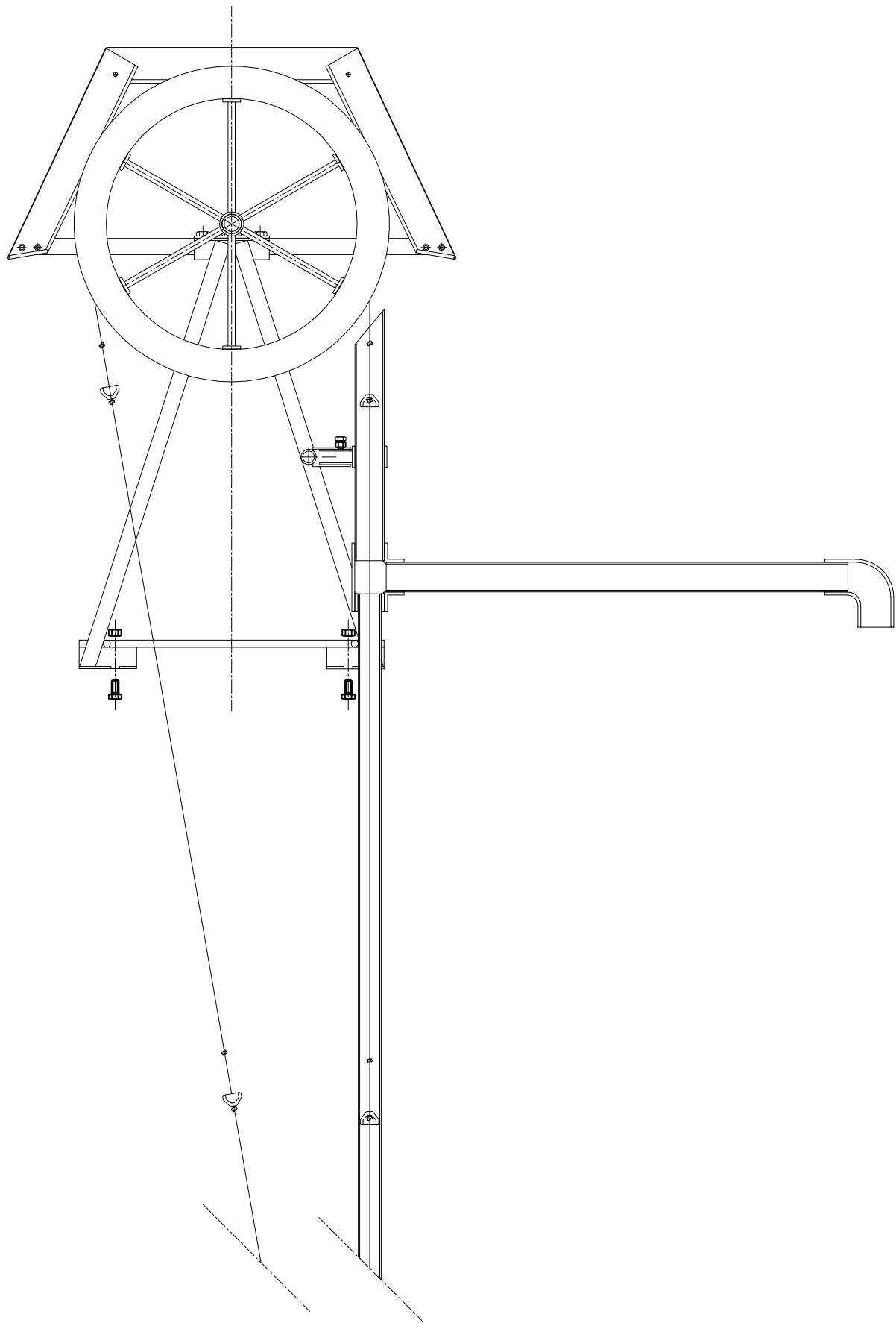
Rope pump Ethiopia AH 'hand dug well'

| Piece | Material | Scale | Date | |
|----------|----------|-------|----------|----------|
| Assembly | | 1:12 | 18.03.06 | PRACTICA |



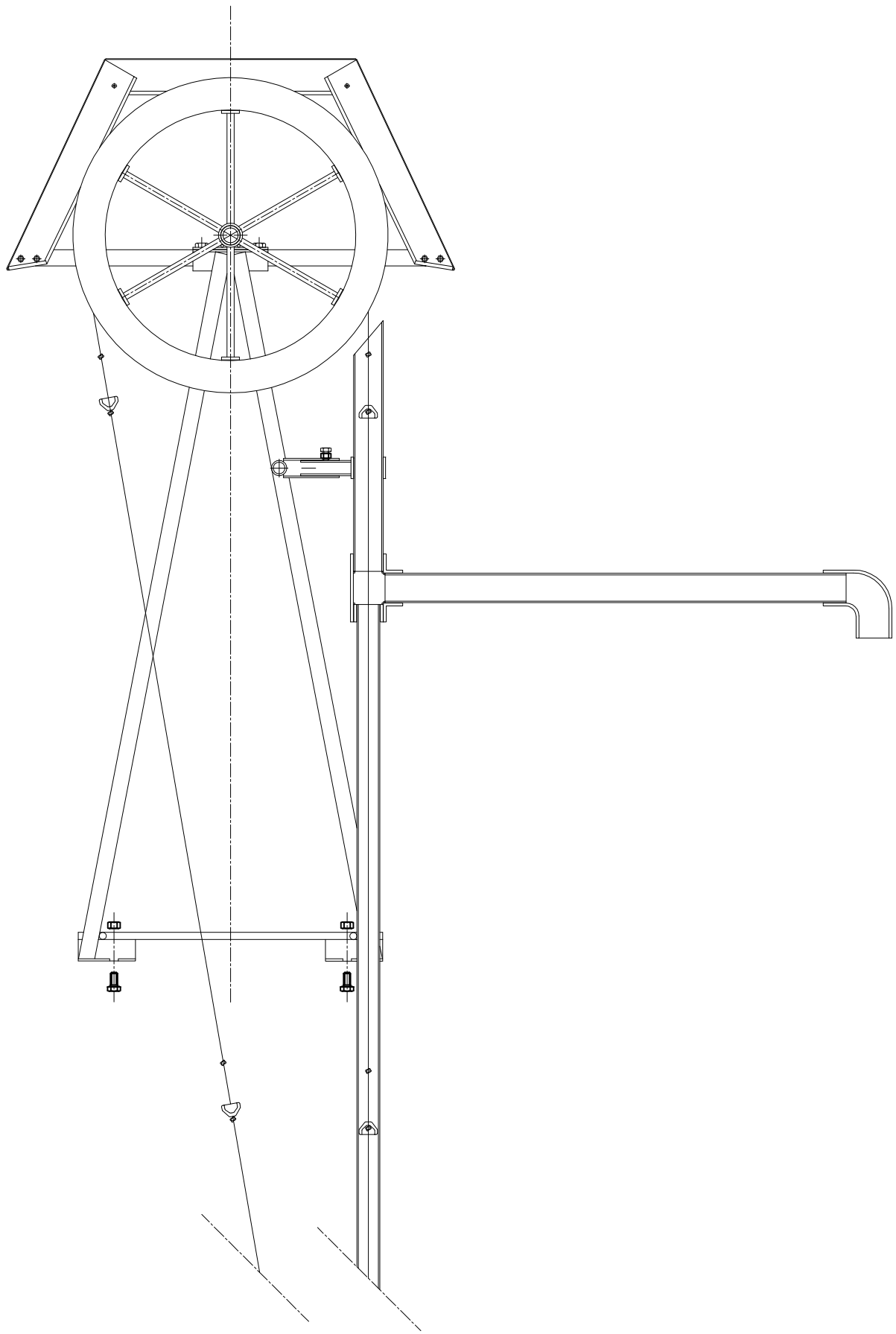
Rope pump Ethiopia AB 'borehole'

| Piece | Material | Scale | Date | |
|----------|----------|-------|----------|----------|
| Assembly | | 1:12 | 18.03.06 | PRACTICA |



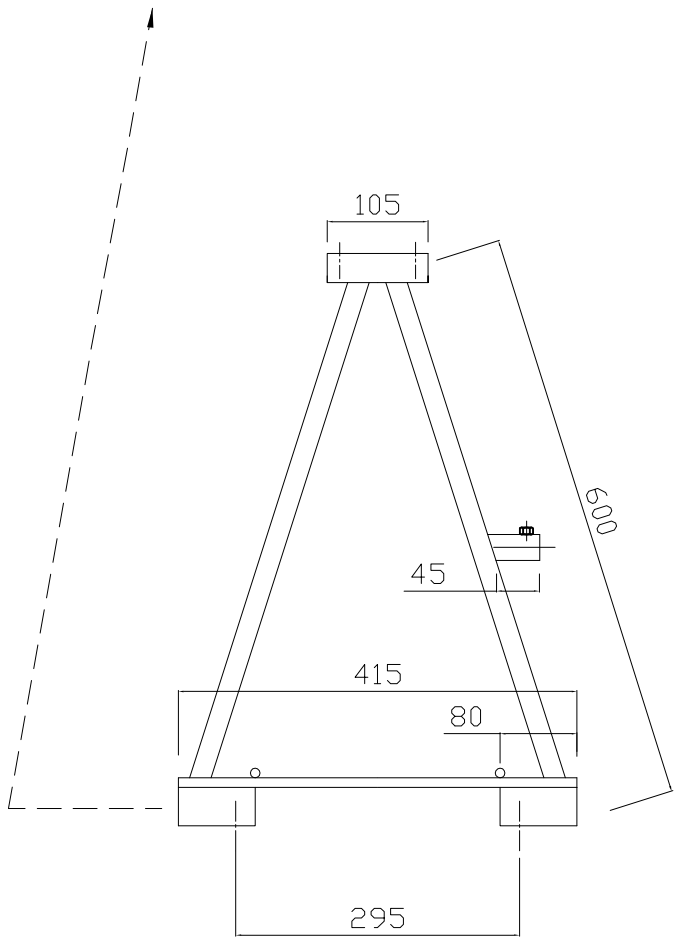
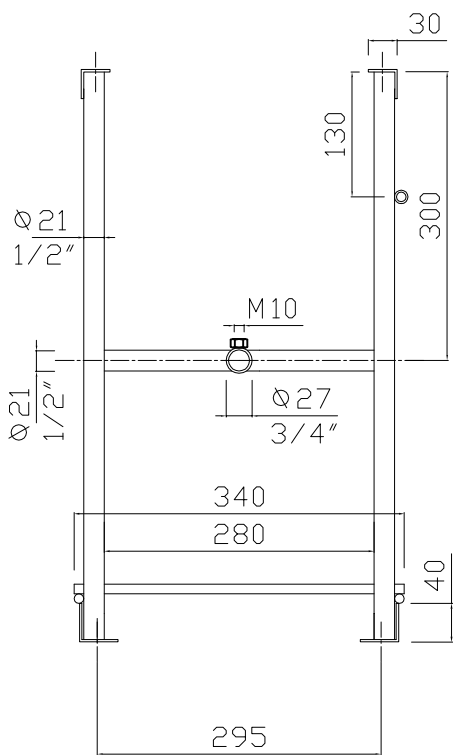
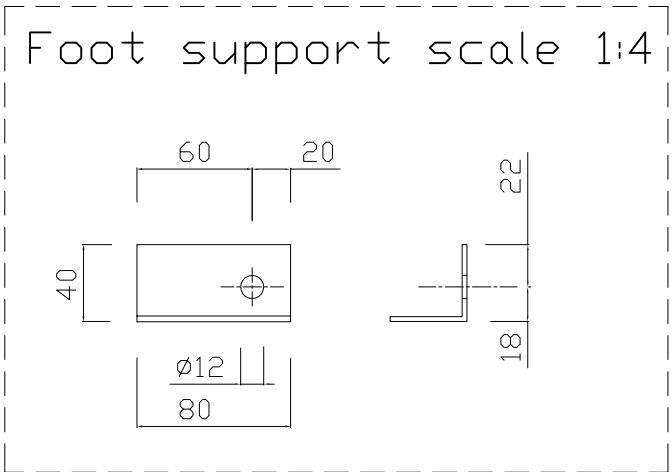
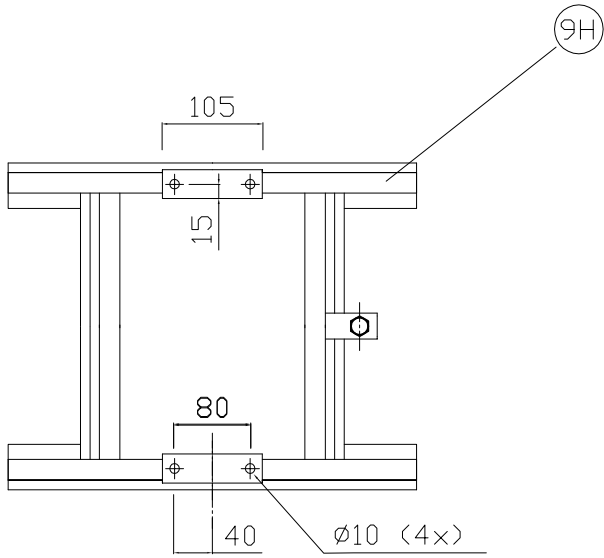
Rope pump Ethiopia AH 'hand dug well'

| Piece | Material | Scale | Date | |
|-----------|----------|-------|----------|----------|
| Section A | | 1:8 | 18.03.06 | PRACTICA |



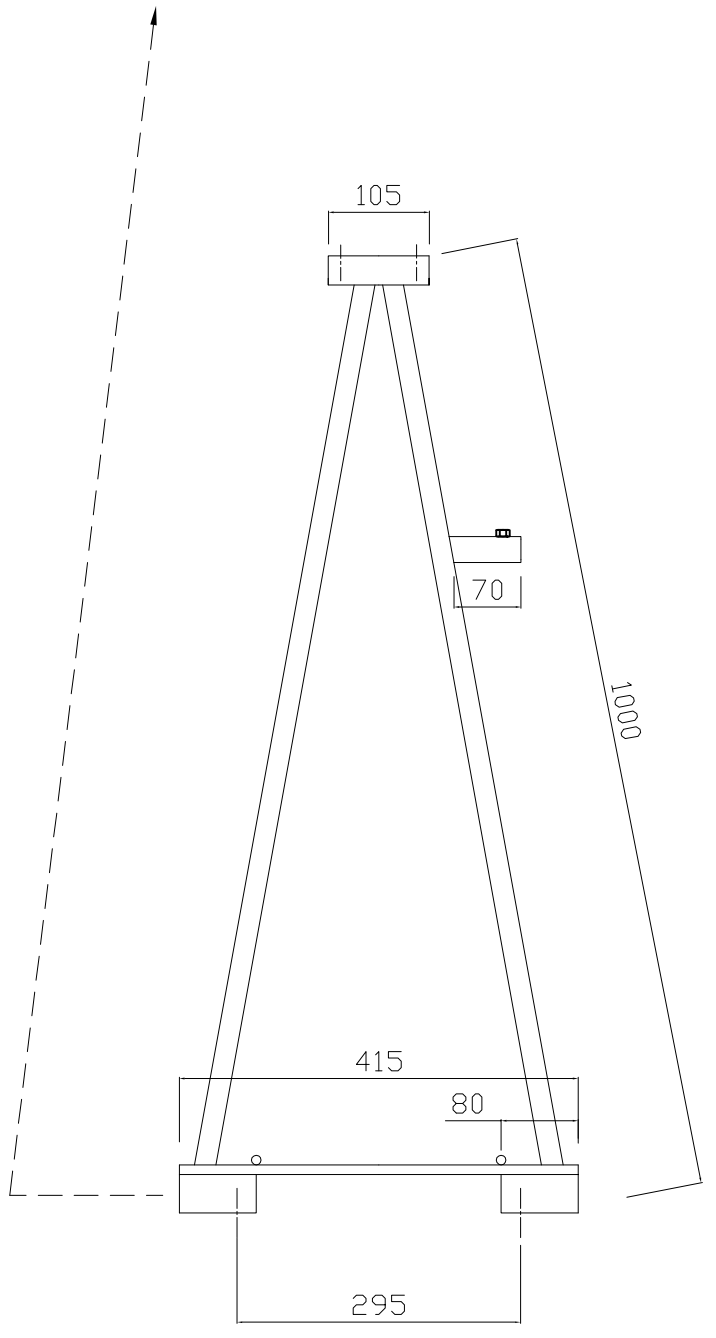
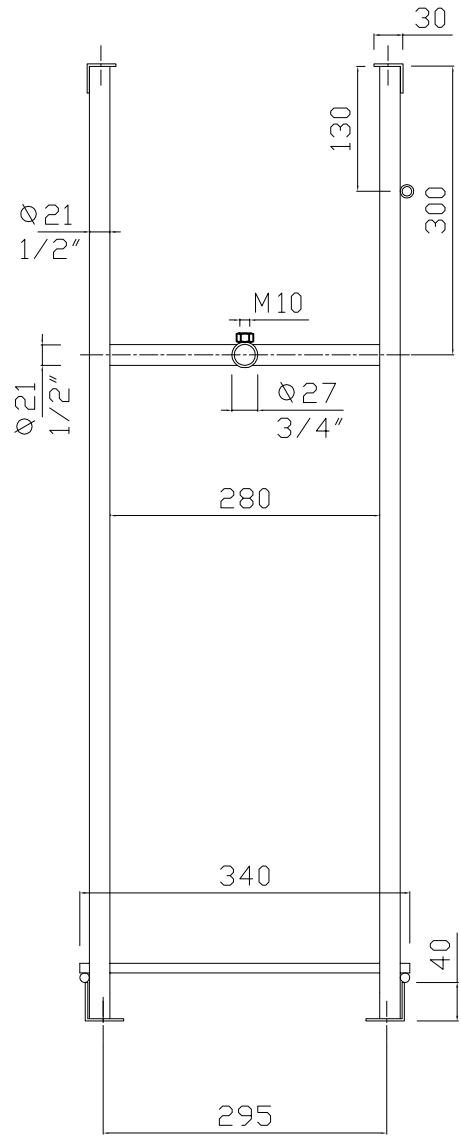
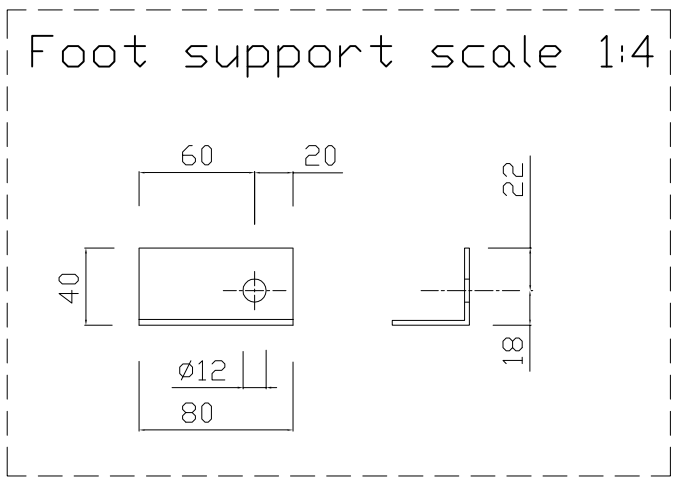
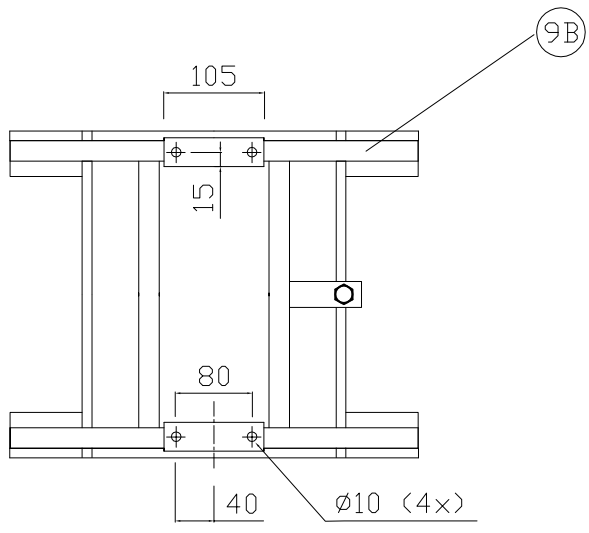
Rope pump Ethiopia AB 'borehole'

| Piece | Material | Scale | Date | |
|-----------|----------|-------|----------|----------|
| Section B | | 1:8 | 18.03.06 | PRACTICA |



Rope pump Ethiopia AH 'hand dug well'

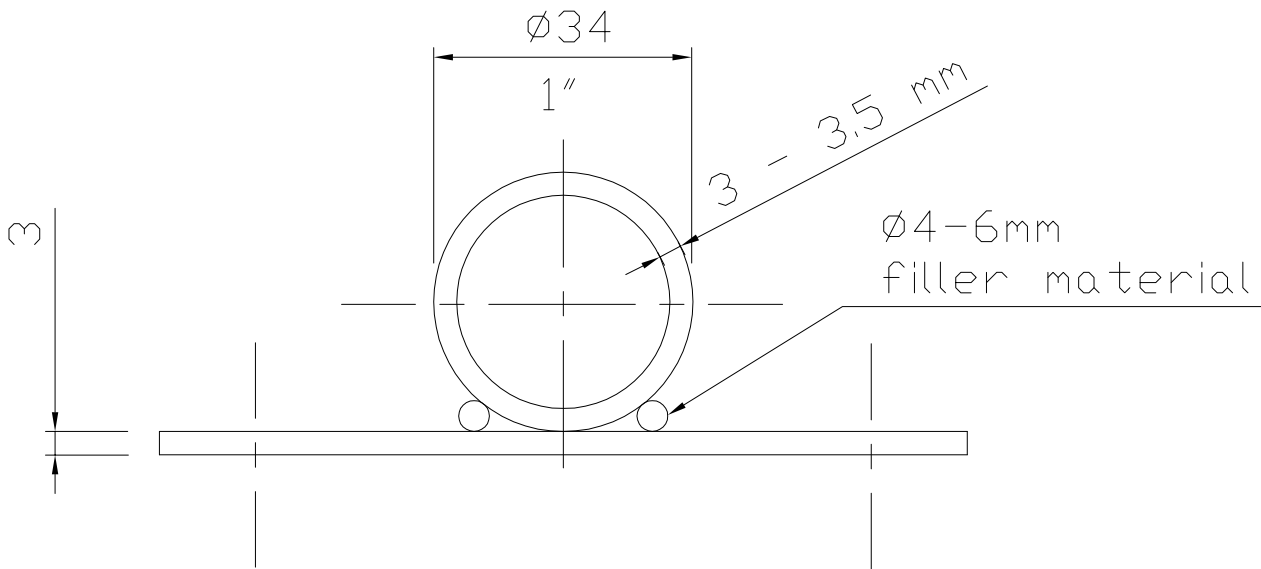
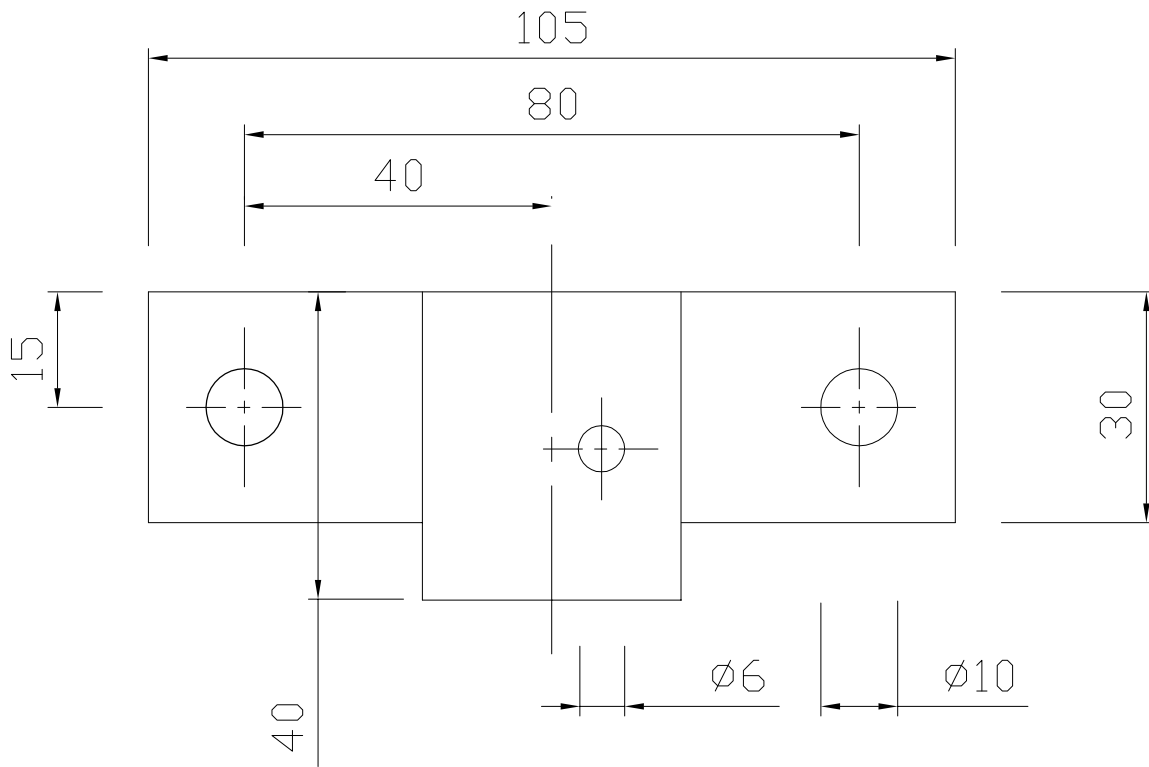
| Piece | Material | Scale | Date | |
|-----------|--------------|-------|----------|----------|
| Structure | GI pipe/Fe36 | 1:8 | 18.03.06 | PRACTICA |



Rope pump Ethiopia AB 'borehole'

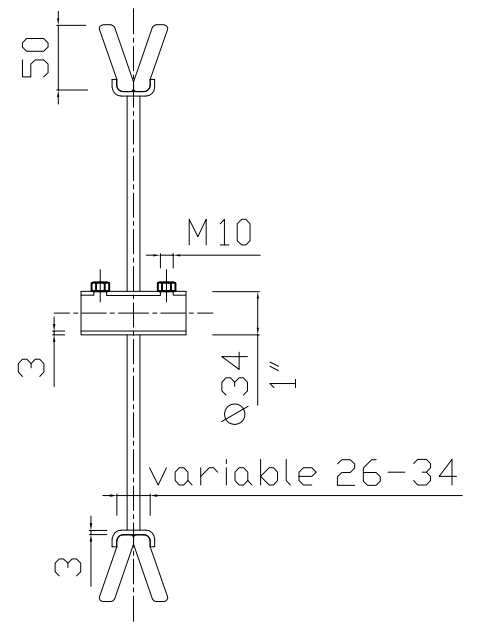
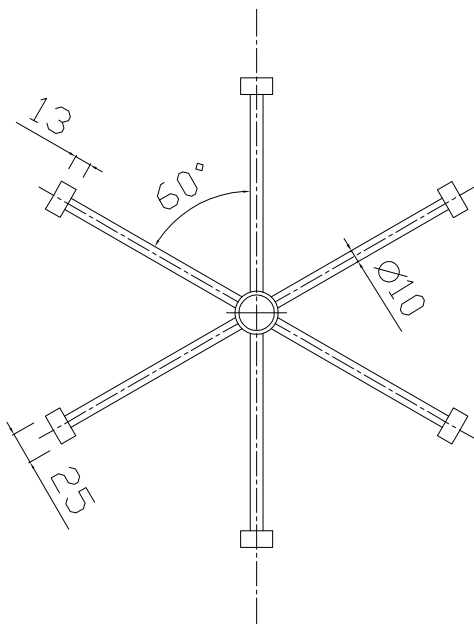
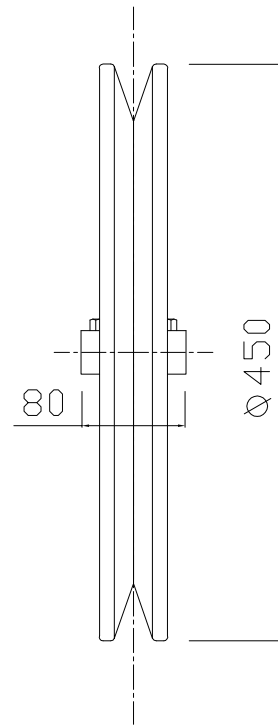
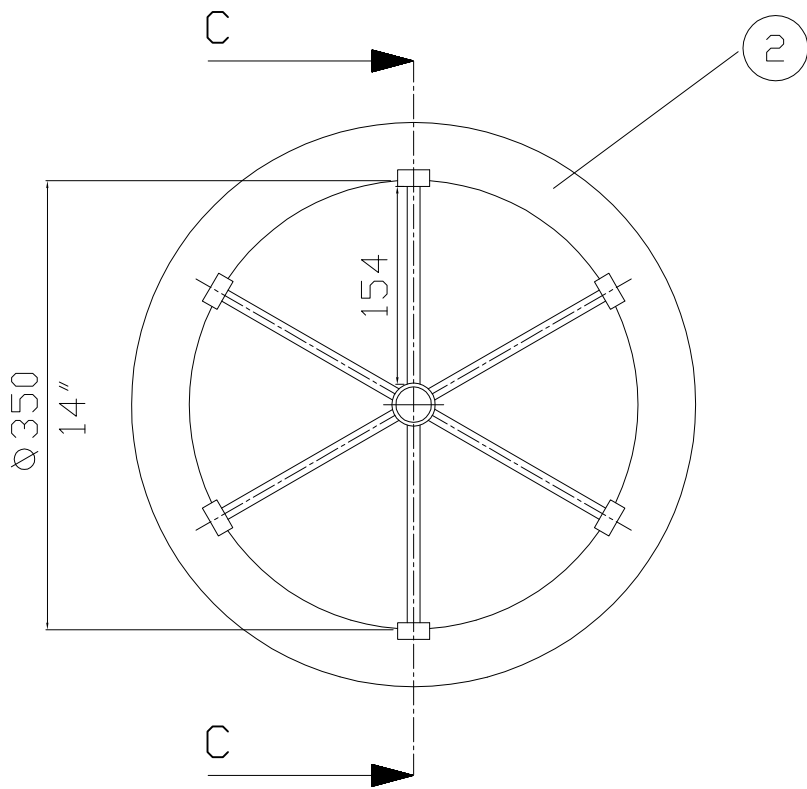
| Piece | Material | Scale | Date | |
|-----------|--------------|-------|----------|----------|
| Structure | GI pipe/Fe36 | 1:8 | 18.03.06 | PRACTICA |

15



Rope pump Ethiopia

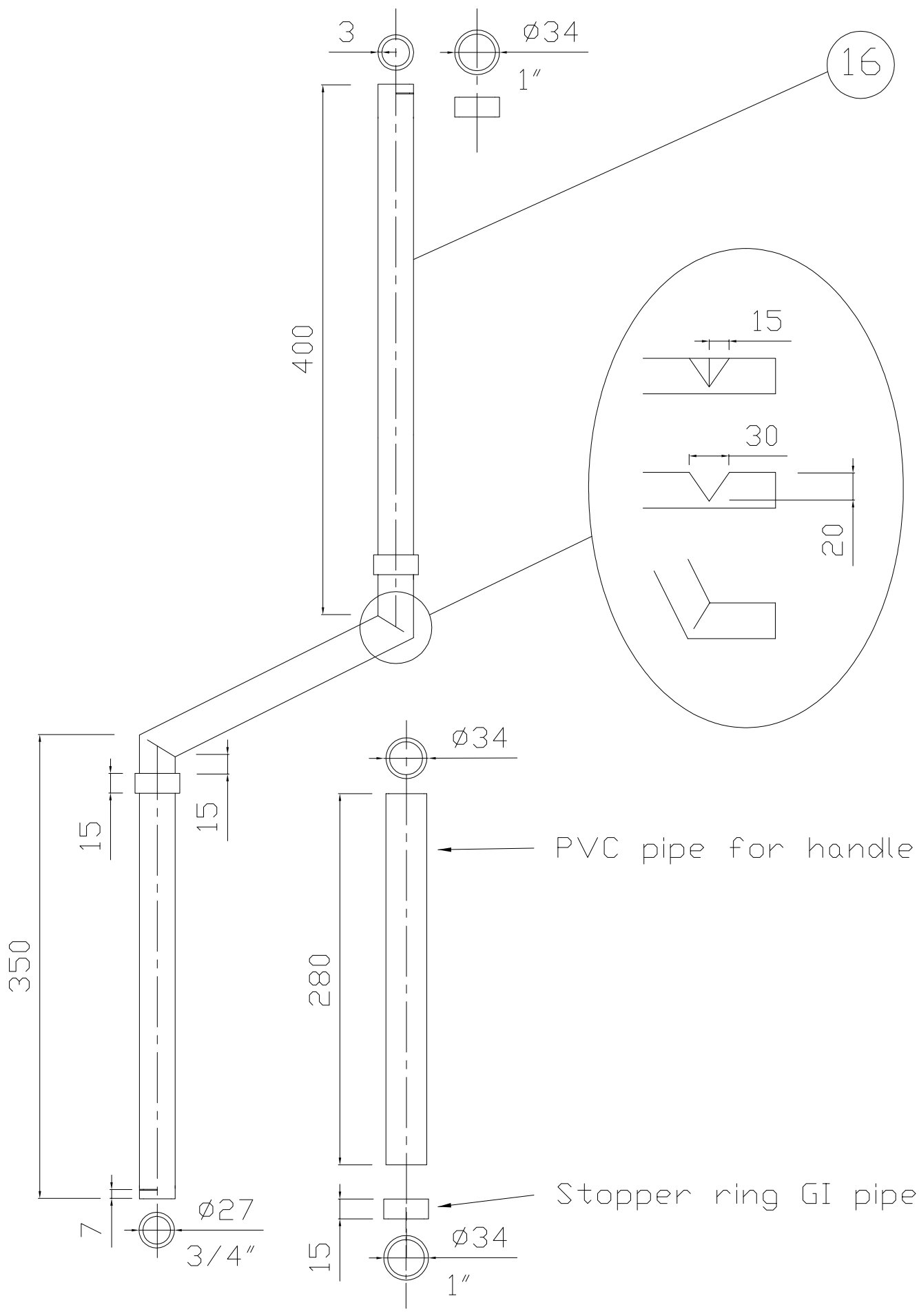
| Piece | Material | Scale | Date | |
|---------|--------------|-------|----------|----------|
| Bushing | Fe36/GI pipe | 1:1 | 18.03.06 | PRACTICA |



section C

Rope pump Ethiopia

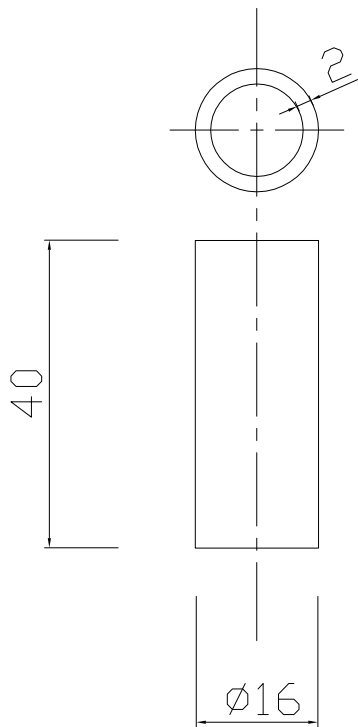
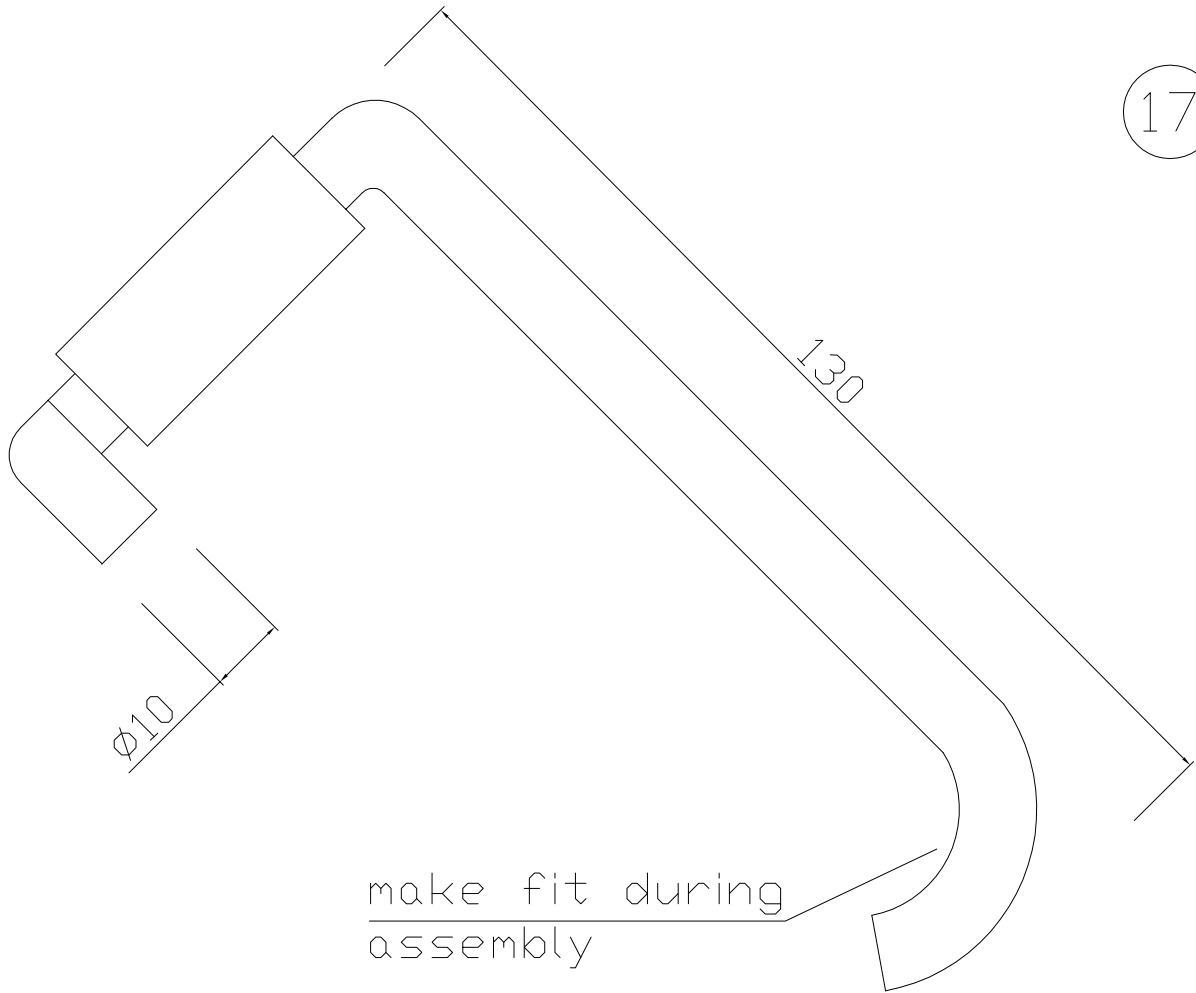
| Piece | Material | Scale | Date | |
|-------|-----------------------|-------|----------|----------|
| Wheel | Fe36/GI pipe/car tire | 1:6 | 18.03.06 | PRACTICA |



Rope pump Ethiopia

| Piece | Material | Scale | Date | |
|-------------|------------------|-------|----------|----------|
| Axle/Handle | GI pipe/PVC grip | 1:4 | 18.03.06 | PRACTICA |

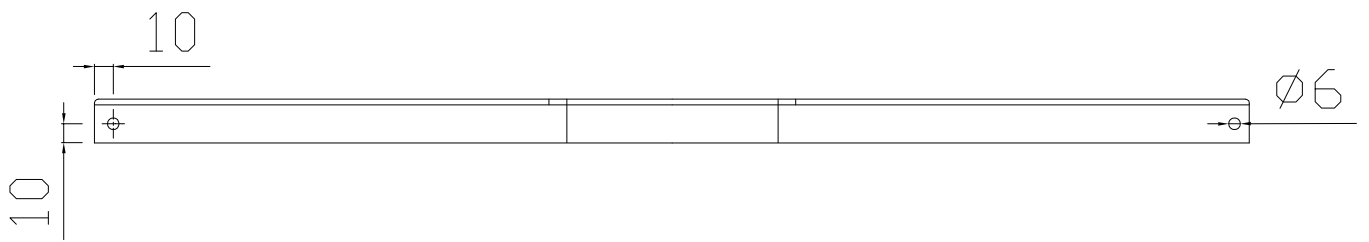
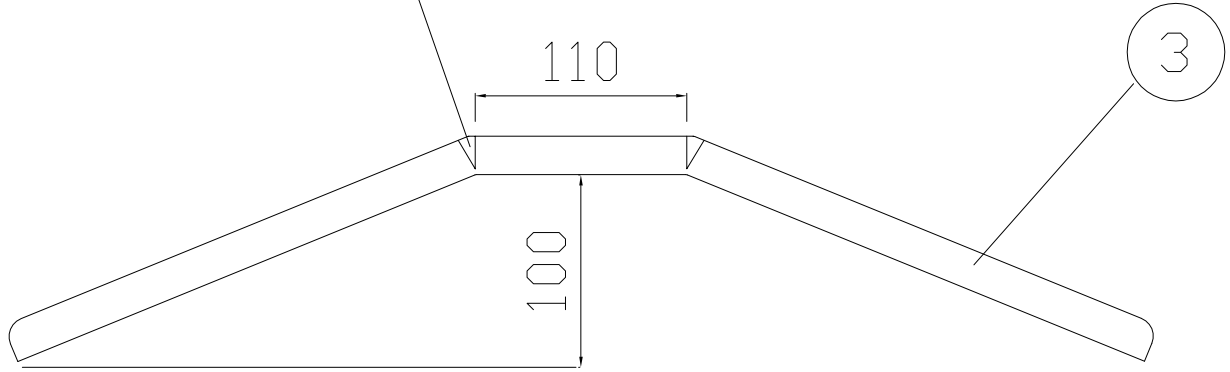
17



Rope pump Ethiopia

| Piece | Material | Scale | Date | |
|-----------|----------|-------|----------|----------|
| Pump lock | Fe36 | 1:1 | 18.03.06 | PRACTICA |

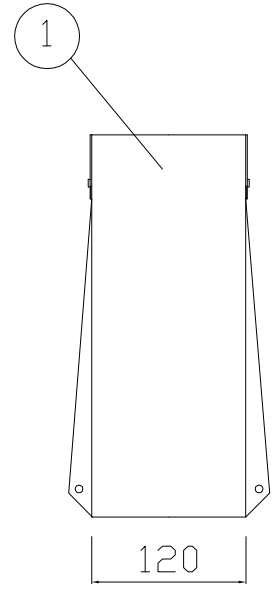
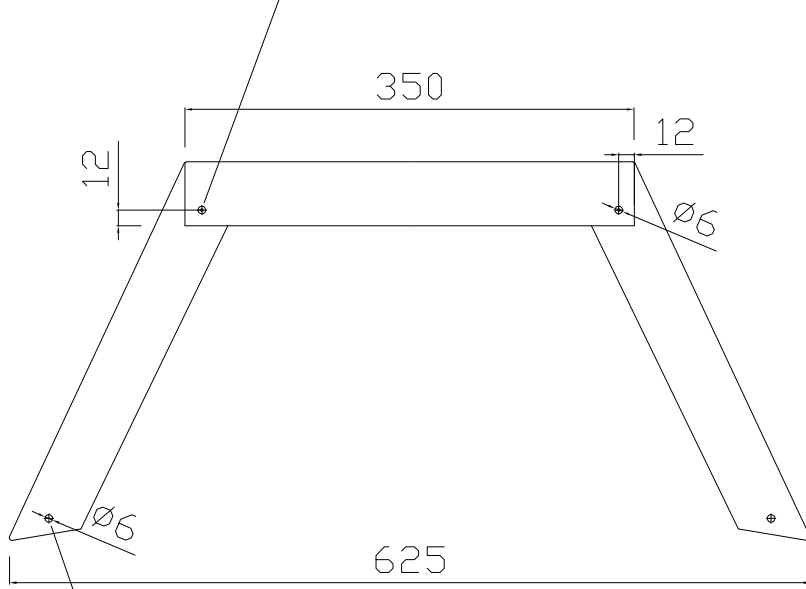
cut and fill
during welding



Rope pump Ethiopia

| Piece | Material | Scale | Date | |
|---------------|----------|-------|----------|----------|
| Cover support | Fe36 | 1:4 | 18.03.06 | PRACTICA |

drill and fix with rivet during assembly

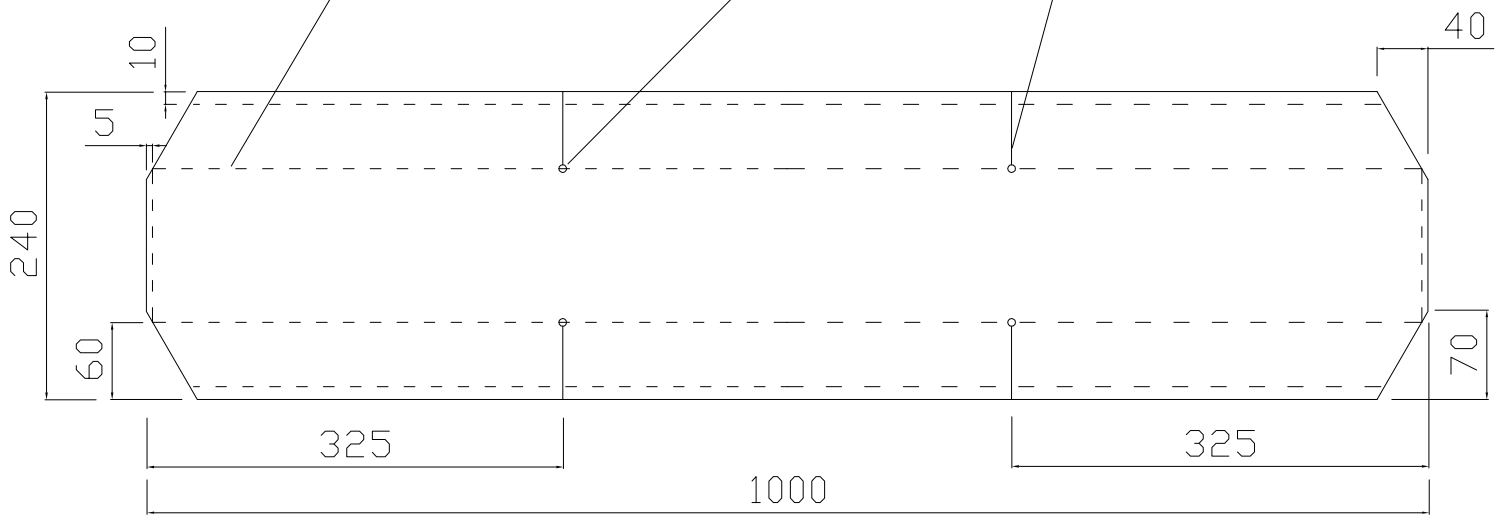


to be drilled during assembly

make hole $\phi 6$ before cutting

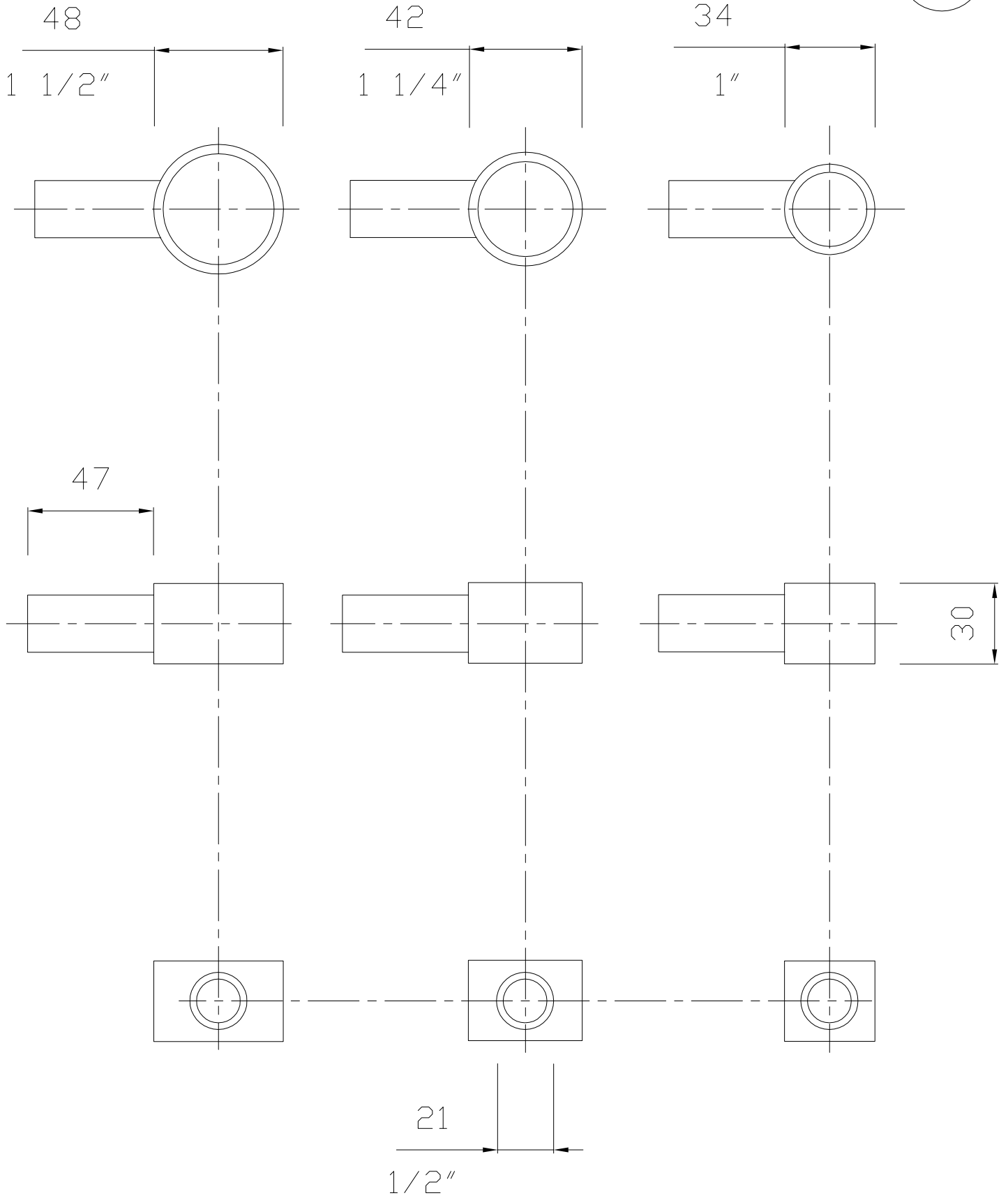
folding line

cutting line



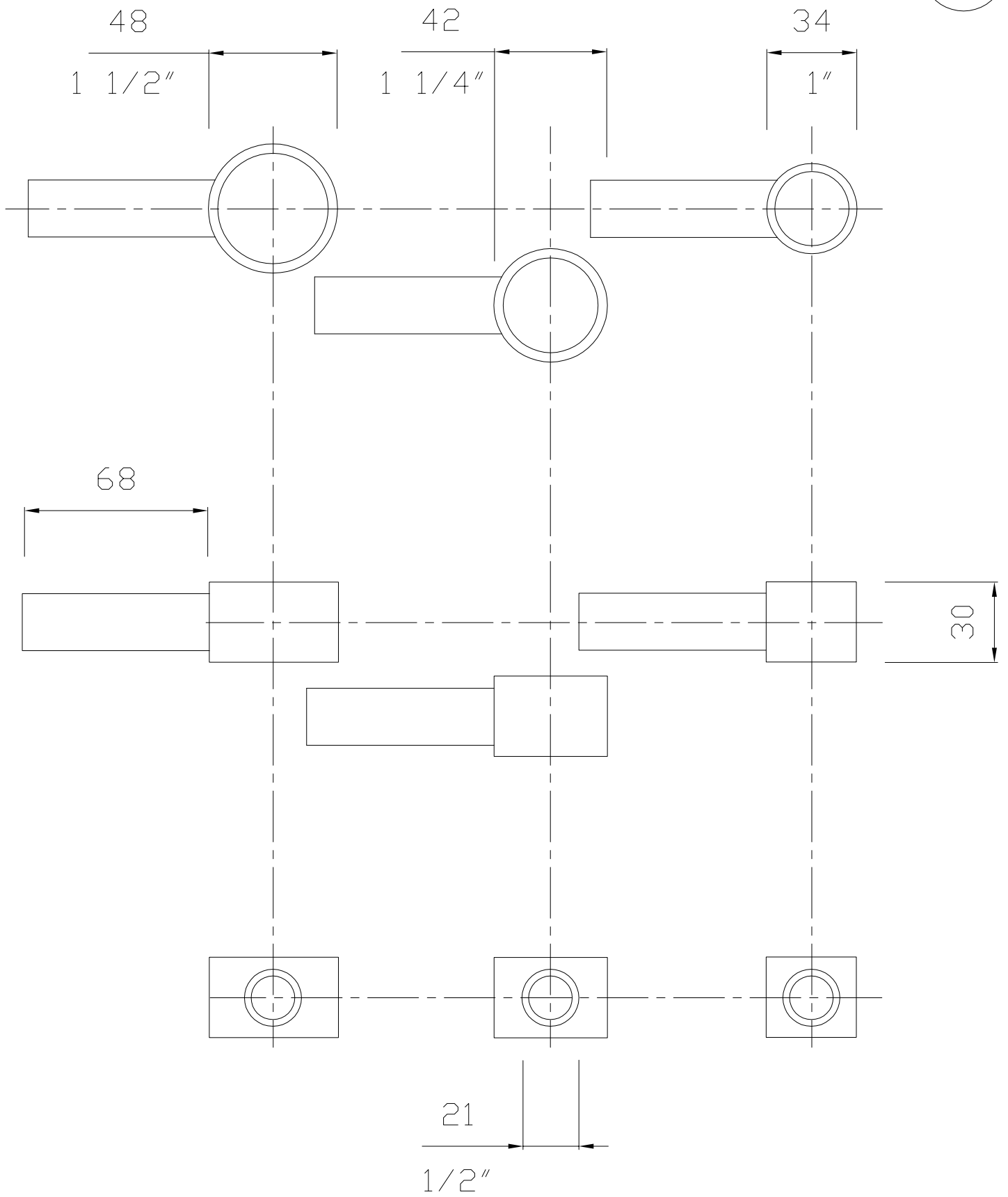
Rope pump Ethiopia

| Piece | Material | Scale | Date | |
|------------|----------------|-------|----------|----------|
| Pump cover | GI sheet metal | 1:6 | 18.03.06 | PRACTICA |



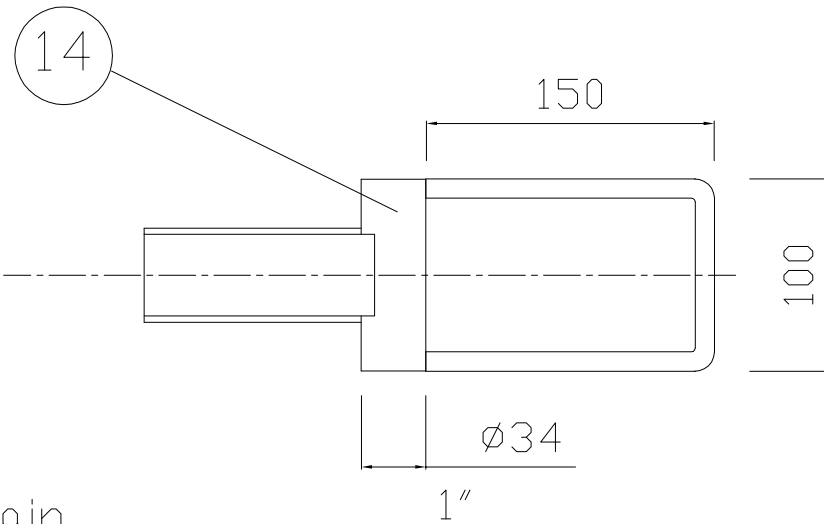
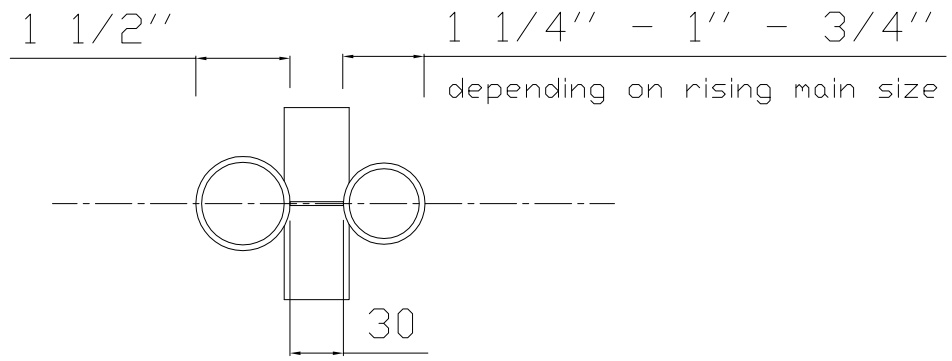
Rope pump Ethiopia AH 'hand dug well'

| Piece | Material | Scale | Date | |
|---------------------|----------|-------|----------|----------|
| Rising main support | GI pipe | 1:2 | 18.03.06 | PRACTICA |

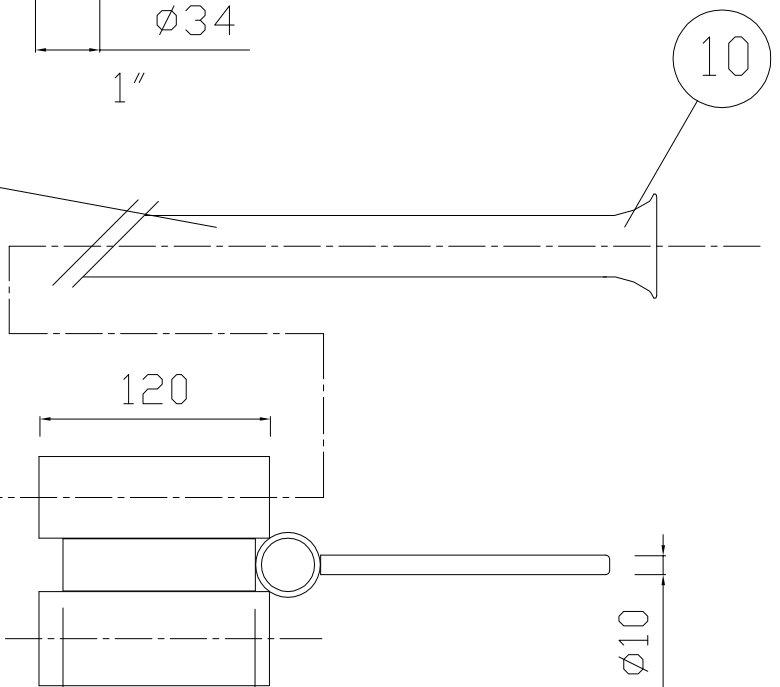


Rope pump Ethiopia AB 'borehole'

| Piece | Material | Scale | Date | |
|---------------------|----------|-------|----------|----------|
| Rising main support | GI pipe | 1:2 | 18.03.06 | PRACTICA |



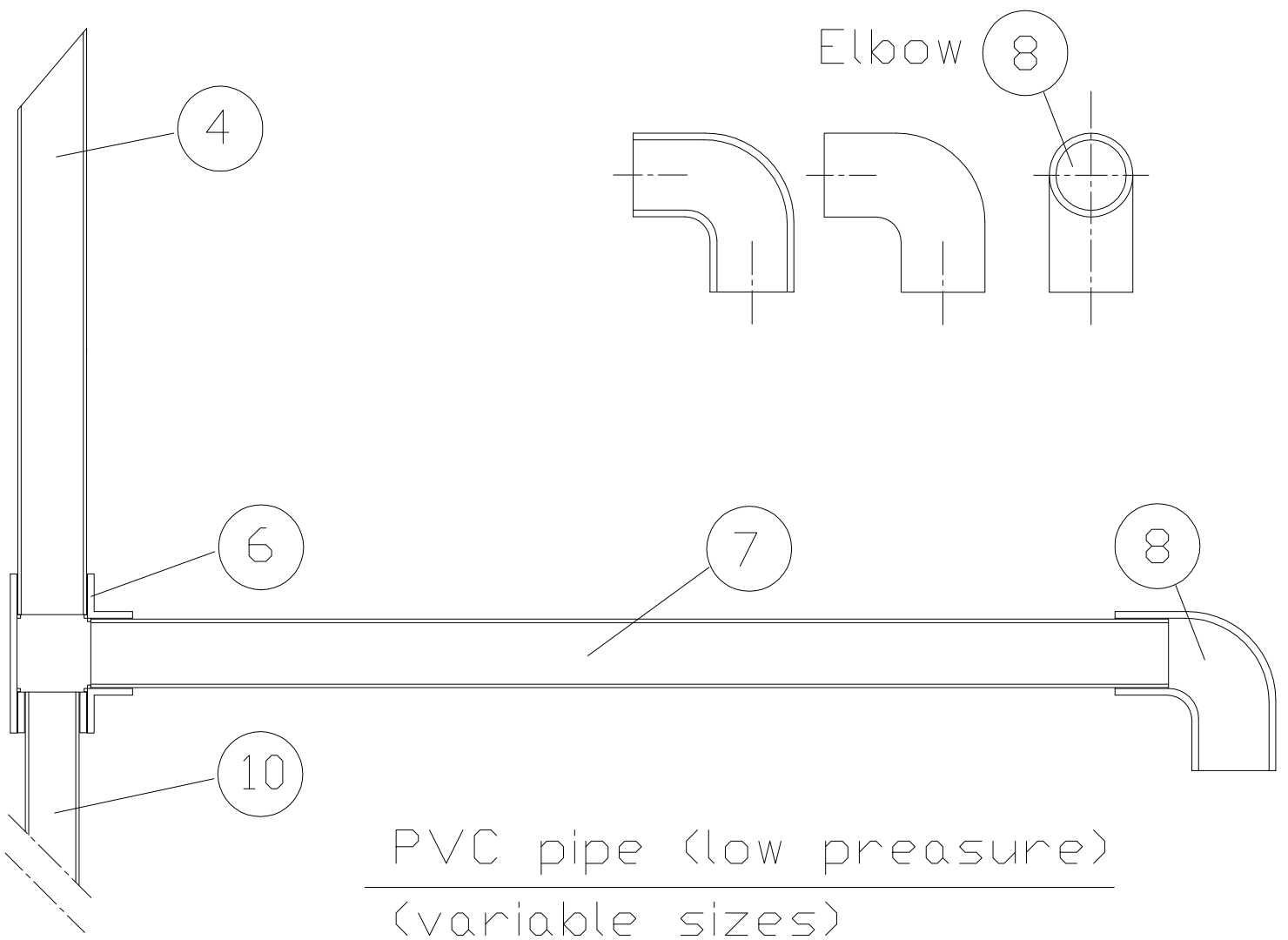
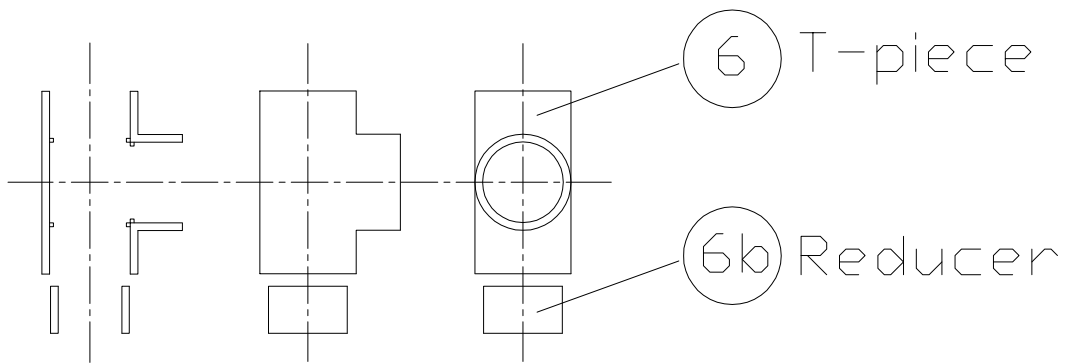
rising main
1" - 3/4" - 1/2" PVC



catcher pipe
1 1/4" PVC

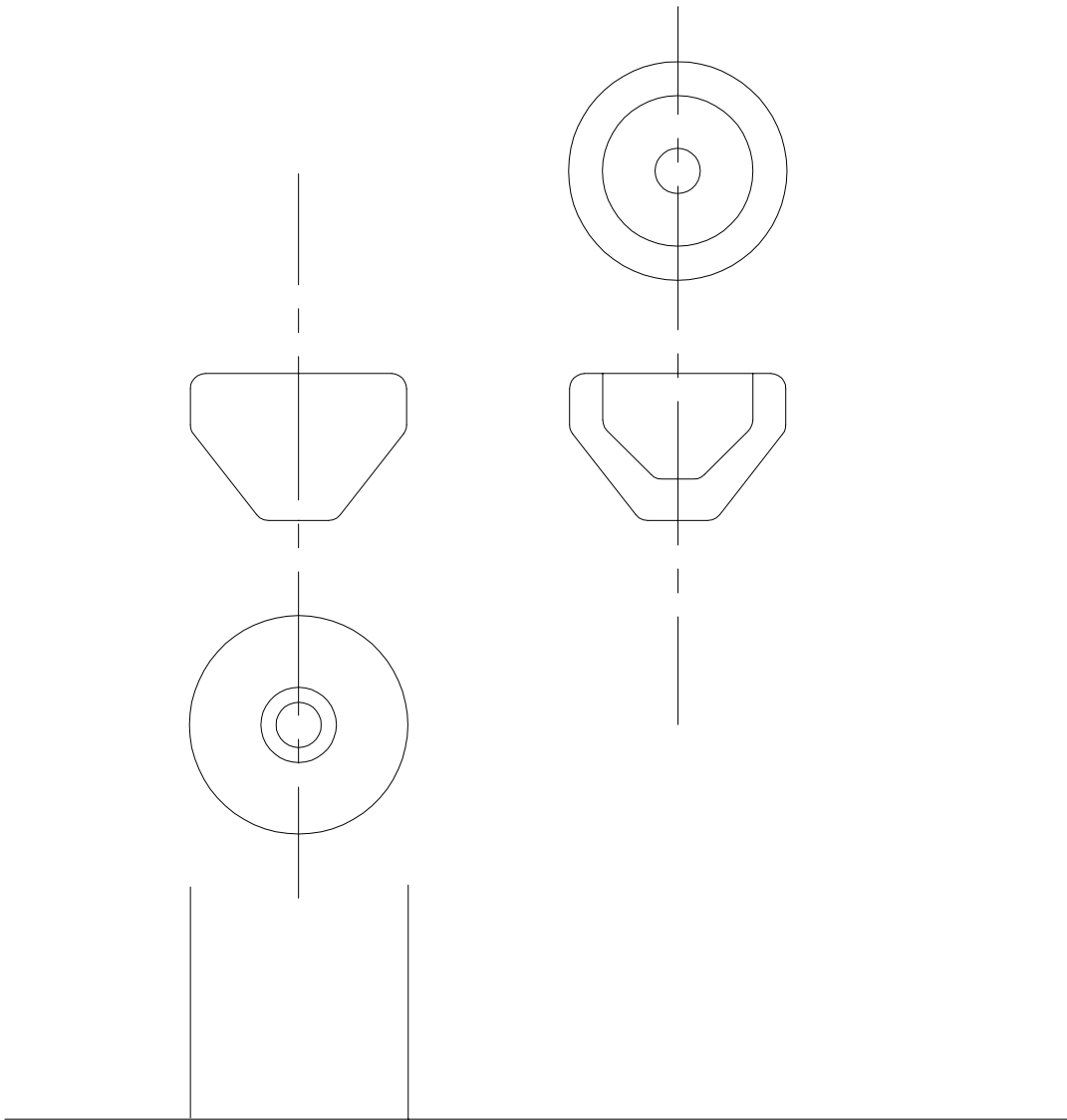
Rope pump Ethiopia

| Piece | Material | Scale | Date | |
|-----------|------------------|-------|----------|----------|
| Guide box | Fe36/GI pipe/PVC | 1:4 | 18.03.06 | PRACTICA |



Rope pump Ethiopia

| Piece | Material | Scale | Date | |
|------------------|----------|-------|----------|----------|
| Outlet/T/Reducer | PVC | 1:4 | 18.03.06 | PRACTICA |



outer diameter of piston = inner diameter of PVC tube - 1mm

Rope pump Ethiopia

| Piece | Material | Scale | Date | |
|--------|--------------------|-------|----------|----------|
| Piston | PE (poly ethylene) | 1:1 | 18.03.06 | PRACTICA |

Annex II C

Material lists

Annex II C

Material list

Rope pump Ethiopia model AH, 'Hand dug well'

Date: March, 2006

| Part No. | Description | Q / pump | Dimensions | Material | Size | Remarks |
|----------|----------------------------|----------|-----------------------|----------------|-----------|-------------------------|
| 1 | Pump cover | 1 | 1000 x 240mm | GI sheet metal | 0.6 – 1mm | cut and fold |
| 2 | Wheel | 1 | | | | |
| | Car tire rim | 2 | Ø 350 x 450mm | Car tire | 14" | |
| | Clamp | 6 | 52 x 25 x 3mm | Fe36 | | strip reinforcement bar |
| | Spoke | 6 | Ø 10 x 154mm | Fe36 | | |
| | Hub | 1 | 80mm | GI pipe | 1" | |
| 3 | Cover support | 2 | 630 x 20 x 20 x 3mm | Fe36 | | angle iron |
| 4 | Top pipe | 1 | variable | PVC | variable | |
| 5H | Rising main support | 1 | | | | |
| | axle | 1 | 47mm | GI pipe | ½ " | |
| | holder | 1 | 30mm | GI pipe | variable | |
| 6 | T-piece | 1 | variable | PVC | variable | |
| 7 | Outlet | 1 | variable | PVC | variable | |
| 8 | Elbow | 1 | variable | PVC | variable | |
| 9H | Structure | 1 | | | | |
| | standard | 4 | 600mm | GI pipe | ½ " | |
| | cross pipe | 2 | 280mm | GI pipe | ½ " | |
| | struc. support | 2 | Ø 10 x 415mm | Fe36 | | reinforcement bar |
| | struc. support | 2 | Ø 10 x 340mm | Fe36 | | reinforcement bar |
| | base support | 4 | 80 x 40 x 40 x 2.5mm | Fe36 | | angle iron |
| | bushing support | 2 | 105 x 30 x 30 x 2.5mm | Fe36 | | angle iron |
| | rising main holder | 1 | 45mm | GI pipe | ¾ " | |
| 10 | Rising main | 1 | variable | PVC | | |
| 11 | Piston | variable | variable | PE | variable | |
| 12 | Rope | 1 | variable | PP | 6mm | |
| 13 | Catcher pipe | 1 | variable | PVC | variable | flared |
| 14 | Guide box | 1 | | | | |
| | base | 1 | 100mm | GI pipe | 1" | |
| | rising main supp. | 1 | 120mm | GI pipe | variable | |
| | flare support | 1 | 120mm | GI pipe | 1 ½ " | |
| | base support | 1 | 100 x 30 x 3mm | Fe36 | | strip reinforcement bar |
| | rope protection | 1 | Ø 10 x 400mm | Fe36 | | |
| 15 | Bushing | 2 | | | | |
| | bushing | 2 | 40mm | GI pipe | 1" | 3-3.5mm wall thickness |
| | base | 2 | 105 x 30 x 3mm | Fe36 | | strip reinforcement bar |
| | welding support | 4 | Ø 6 x 40mm | Fe36 | | |
| 16 | Axle and handle | 1 | | | | |
| | base | 1 | 1000mm | GI pipe | ¾ " | 3-3.5mm wall thickness |
| | ring | 4 | 15mm | GI pipe | 1" | |
| | grip | 1 | 280mm | PVC | 27mm | inner diameter |
| 17 | Pump lock | 1 | | | | |
| | holder | 1 | 40mm | Fe/GI pipe | Ø 16mm | |
| | lock | 1 | Ø 10 x 190mm | Fe36 | | reinforcement bar |

Rope pump Ethiopia model AB, 'Borehole'

Date: March 2006

| Part No. | Description | Q / pump | Dimensions | Material | Size | Remarks |
|----------|---|--------------------------------------|--|---|-------------------------------------|--|
| 1 | Pump cover | 1 | 1000 x 240mm | GI sheet metal | 0.6 – 1mm | cut and fold |
| 2 | Wheel Car tire rim Clamp Spoke Hub | 1 2 6 6 1 | Ø 350 x 450mm 52 x 25 x 3mm Ø 10 x 154mm 80mm | Car tire Fe36 Fe36 GI pipe | 14" 1" | strip reinforcement bar |
| 3 | Cover support | 2 | 630 x 20 x 20 x 3mm | Fe36 | | angle iron |
| 4 | Top pipe | 1 | variable | PVC | variable | |
| 5B | Rising main support axle holder | 1 1 1 | 68mm 30mm | GI pipe GI pipe | ½ " variable | |
| 6 | T-piece | 1 | variable | PVC | variable | |
| 7 | Outlet | 1 | variable | PVC | variable | |
| 8 | Elbow | 1 | variable | PVC | variable | |
| 9B | Structure standard cross pipe struc. support struc. support base support bushing support rising main holder | 1 4 2 2 2 4 2 1 | 1000mm 280mm Ø 10 x 415mm Ø 10 x 340mm 80 x 40 x 40 x 2.5mm 105 x 30 x 30 x 2.5mm 70mm | GI pipe GI pipe Fe36 Fe36 Fe36 Fe36 GI pipe | ½ " ½ " ¾ " | reinforcement bar reinforcement bar angle iron angle iron |
| 10 | Rising main | 1 | variable | PVC | | |
| 11 | Piston | variable | variable | PE | variable | |
| 12 | Rope | 1 | variable | PP | 6mm | |
| 13 | Catcher pipe | 1 | variable | PVC | variable | flared |
| 14 | Guide box base rising main supp. flare support base support rope protection | 1 1 1 1 1 | 100mm 120mm 120mm 100 x 30 x 3mm Ø 10 x 400mm | GI pipe GI pipe GI pipe Fe36 Fe36 | 1" variable 1 ½ " | strip reinforcement bar |
| 15 | Bushing bushing base welding support | 2 2 2 4 | 40mm 105 x 30 x 3mm Ø 6 x 40mm | GI pipe Fe36 Fe36 | 1" | 3-3.5mm wall thickness strip reinforcement bar |
| 16 | Axle and handle base ring grip | 1 1 4 1 | 1000mm 15mm 280mm | GI pipe GI pipe PVC | ¾ " 1" 27mm | 3-3.5mm wall thickness inner diameter |
| 17 | Pump lock holder lock | 1 1 1 | 40mm Ø 10 x 190mm | Fe/GI pipe Fe36 | Ø 16mm | reinforcement bar |

Annex III

Tools and materials for installation

Materials:

- Rising main as long as the depth of the well + 2 meter, of the right diameter.

Important:

PVC parts need to be of the same brand and same measurements.

- T-piece
- Reducer
- Elbow
- PVC tubing for outlet and top pipe
- PVC glue
- Guide box
- Rope with pistons.
- Rubber strips made of inner tire tubes: 2 meter total length, width 30 mm

Tools:

- 2 Spanners (M10)
- Knife
- Pliers
- Pipe-cutting saw
- Sandpaper
- Hammer
- Measuring tape
- Flaring tools
- Pole to lift the slab
- Thin rope, with a length more as the total depth of the well
- Cigarette lighter to burn the ends of the rope
- Candle

