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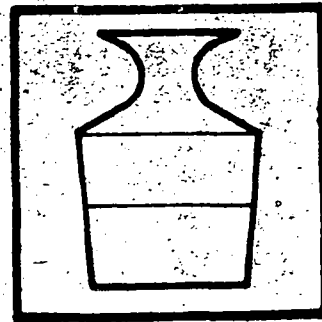
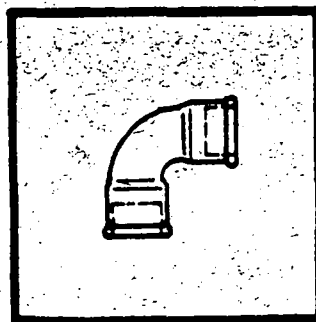
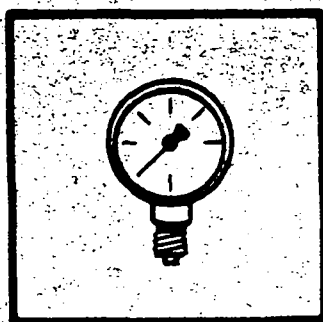
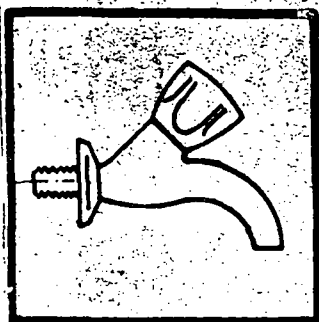
# MANUAL

for

# WATER SYSTEMS

and

# PIPE WORK



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# A BRIEF

INTRODUCTION COURSE

FOR THE ESTABLISHMENTS  
OF RURAL WATER SUPPLIES  
IN NEPAL

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NIR MAN JOSHI

c/o SWISS ASSOCIATION  
FOR TECH. ASSISTANCE

DRAFTSMAN. BYS

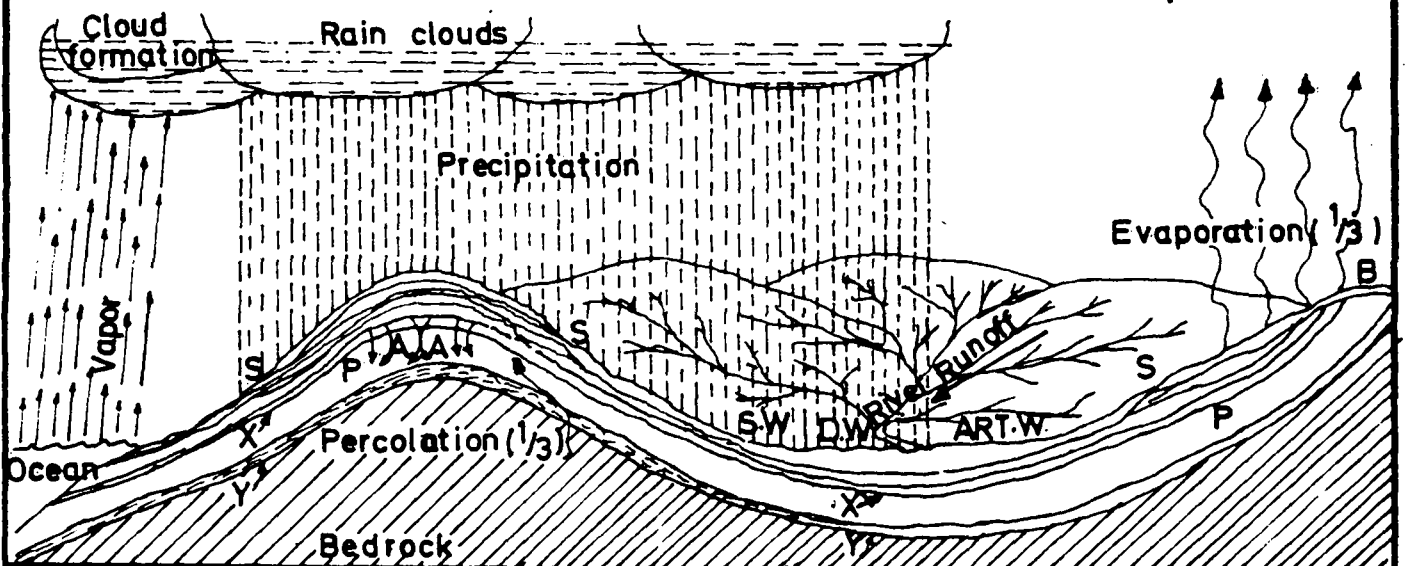
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## Importance of Water

- Water is essential for life
- Water is essential for health and sanitation
- Water is the principal raw material for food production
- Water is important for many uses outside the home and on the farm
- Water conservation and sanitatation are important to everyone.

## The Water Cycle



A cross section of a possible arrangement of the earth crust showing how water may be distributed over and through it.

A part of the rainfall runs off at the surface forming creeks and rivers; a part may soak into the ground and return to the surface at springs or wells.

Yet another portion may percolate deeper through cracks and faults, ( A-A and B) into a porous strata (P) where it may be carried many miles to the ocean or to artesian wells.

S	=	Springs
SW + DW	=	Springs or wells
ART.W.	=	Artesian well
P	=	Porous strata
X + Y	=	Watertight strata

## Sources of water for domestic use

- Rain water
- Natural surface waters
- Ground water (best quality)

Development of sources of water

Any new or untried source of water should be examined for quality before expensive development is undertaken.

For watering animals, spraying and irrigation it should at least be clear and free of any minerals, tastes or odors which would be harmful or objectionable to plants or animals.

Quality

The water must be free of

- harmful bacteria
- objectionable minerals
- tastes or odors
- sediment = clear, without color
- temperature about 10 °C ( 50 °F)

Quantity

need for life	- 15 ltr (about 3½ Gallons) per day and person
need for life with washing	- 50 ltr (about 11 Gallons) per day and person

Definitions as applied to water

When used in connection with handling water, head refers to the vertical height of a column of water above a certain point, and is considered as causing or counteracting the flow of water. For example, if water stands at a height of 6 meter ( 20 feet), there will be 6 m (20 feet) of head in the bottom of the pipe. This pressure is expressed in terms in kg per cm<sup>2</sup> (or pounds per square inch, psi). A column of water 10 m high (10 m head) will have a pressure of 1 kg/cm<sup>2</sup>. (By 6 m = 0.6 kg/cm<sup>2</sup>).

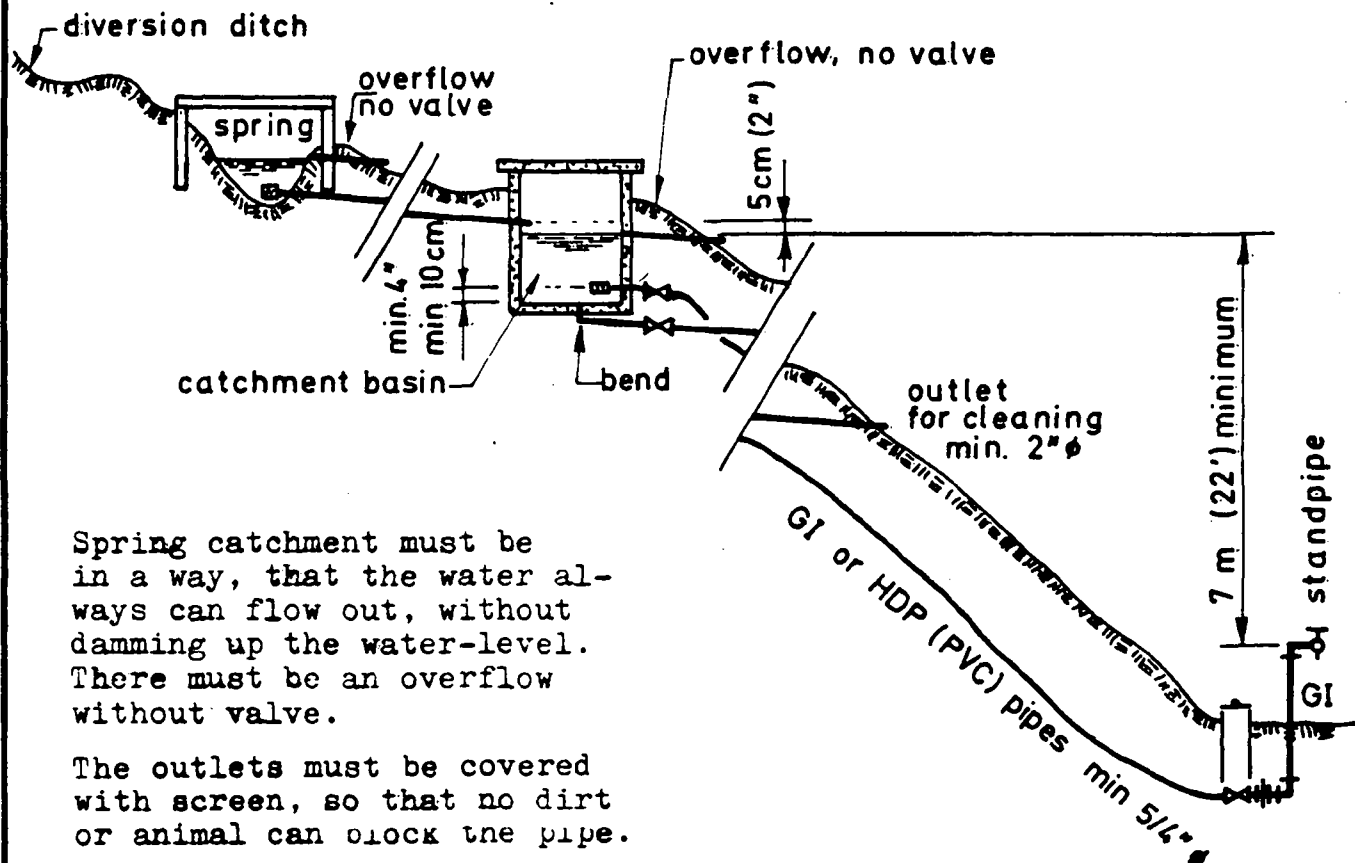
Gravity head is the actual vertical height of a column of water above a reference point.

Pressure Pressure head is the vertical height in meter (feet) to which any given pressure will force water. One kg per cm<sup>2</sup> will force water to a height of 10 m. (or one pound to a height of 2.3 feet).

Suction head a term applied to pumps, is considered as the total equivalent head in meter (feet) on the suction side of the pump against which the pump must work in order to get water.

The equivalent suction head is made up of  
gravity head + friction head

Most pumps are guaranteed to work against 7 m (22 feet) of total suction head at sea level. (As higher as less suction).

NATURAL GRAVITY SYSTEM

Spring catchment must be in a way, that the water always can flow out, without damming up the water-level. There must be an overflow without valve.

The outlets must be covered with screen, so that no dirt or animal can block the pipe.

Gravity Type

a gravity water system is one having a tank or storage reservoir located higher than the faucets from which tank or reservoir water flows to the faucets by the force of gravity.

There are two common types of gravity systems. One is "natural" gravity where the source of the water is high enough above the faucets to provide a satisfactory flow. The other is the "pumped" system where a pump is used to elevate the water to a gravity storage tank located above the faucets.

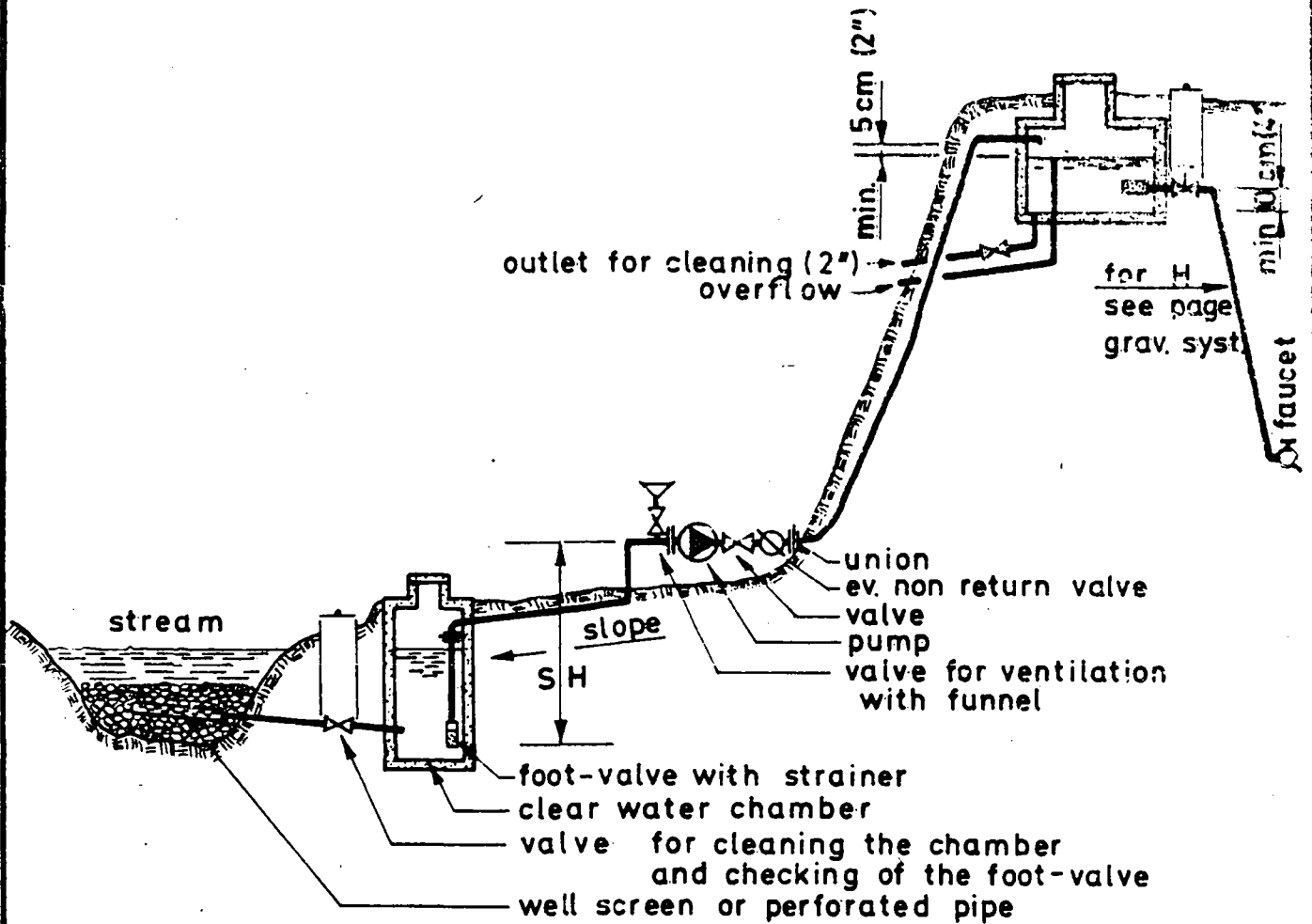
Natural gravity system

The natural gravity system should be considered only when the source of water is high enough above the faucets (stand-pipes or buildings) to give adequate flow.

Unless the spring has a strong flow, a catchment basin should be built below the spring as shown. For a satisfactory flow there should be at least 7m (22') of elevation on the highest faucet. If the system has a great distance, more than 7m is desirable.

A source to be developed should provide an adequate year-round supply of good quality water. Special attention should be given to catchment basins, size and material of pipe to use, and protection from contamination or pollution.

PUMPED GRAVITY SYSTEM



SH = suction head. Must be as low and short as possible. The head is made up of gravity + friction head (= loss). The absolutely maximum of head (GH + FH) is 7m (22') at sea level. (As higher as less H)

Pumped gravity system

If there is no possibility for a natural gravity system, there remains the pumped gravity system. But they are not always recommendable: pumps are expensive, need a lot of maintenance. (gasoline, electricity and service through specialists. Exception: Hydraulic ram)

However, for big quantities and/or if there exists only this possibility it is a very satisfactory system.

A large storage capacity is desirable to provide water for days, it needs a less frequent starting of the engine.

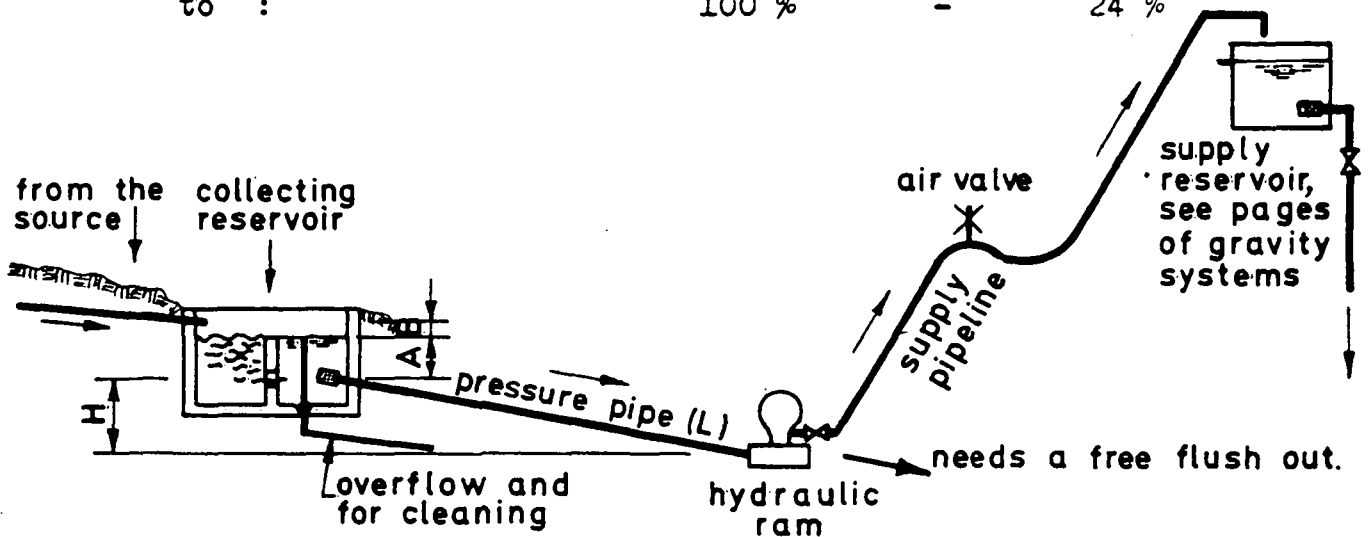
HYDRAULIC RAM

The hydraulic ram is an automatic pump which by means of a relatively small gradient raises a part of the available spring or stream water to a much higher point.

Example: The spring or stream water is being collected in a reservoir. From here a part of this water is to be lifted to the supply reservoir. For this purpose the water is being fed through a pressure pipe into the ram. A part of this volume is then being raised through the supply pipe to the reservoir.

The proportion between pressure pipe quantity + supply pipe quantity can be from:

	100 %	-	3 %
to :	100 %	-	24 %



L = length of pressure pipe 4 - 5 x H

A = 30-40 cm (12-16")

B = at least 10 cm (4")

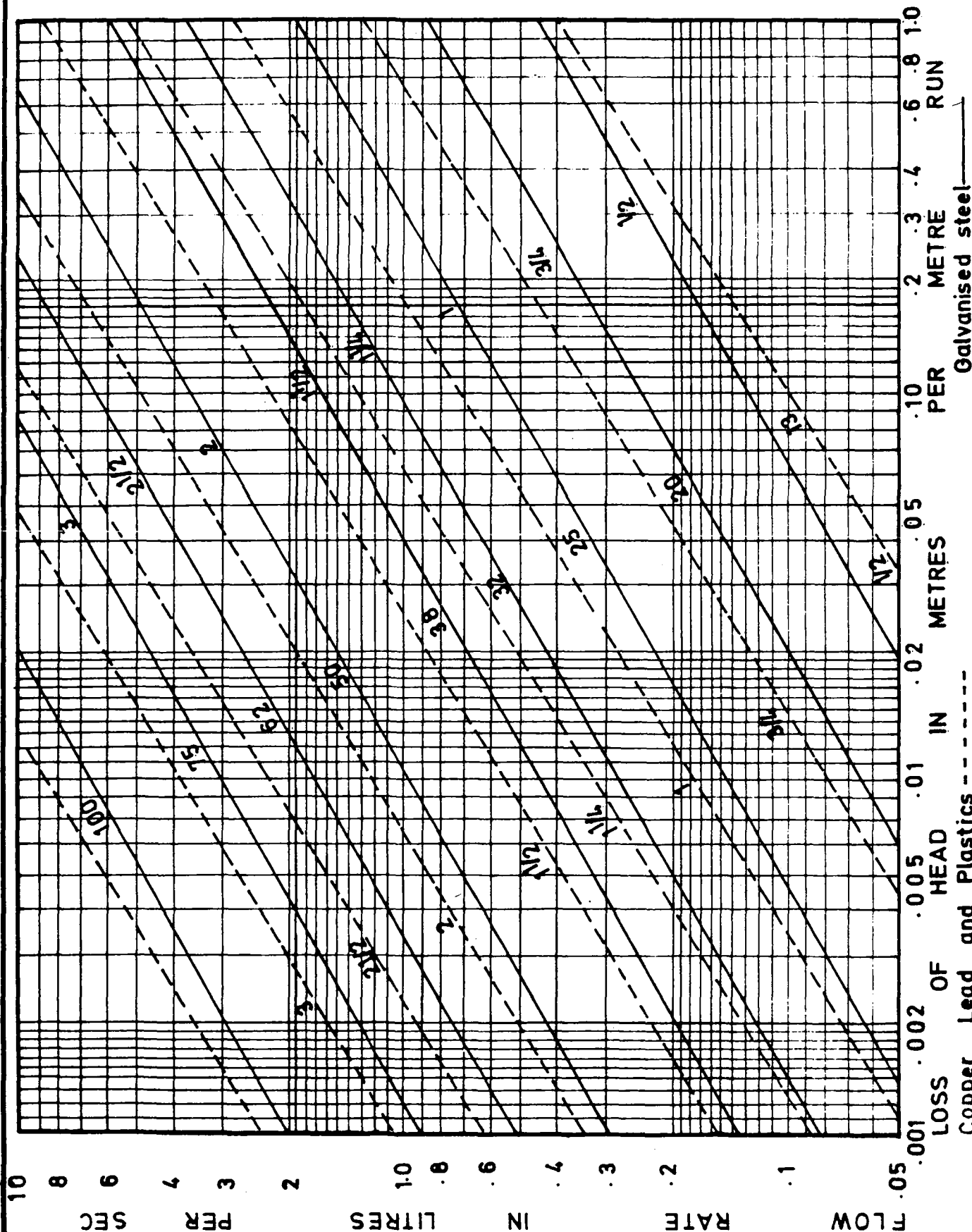
Collecting reservoir: The available water is collected in a reservoir or basin. As far as the water is taken from a stream, this latter can be dammed up for this purpose. The collecting tank can be made in any desired size. It is, however essential, that the pressure pipe intake is always covered under at least 30-40 cm (12-16"). The collecting reservoir must furthermore be constructed in a way which excludes any possibility of air bubbles entering the pressure pipe. Air bubbles in the pressure pipe would hamper the proper operation of the ram.

Pressure pipe: The pressure pipeline must be installed with greatest care. It must in particular be absolutely tight.

Caution: An installation of a ram is a very particular matter, it needs a founded knowledge. Before ordering a hydraulic ram, contact a specialist.

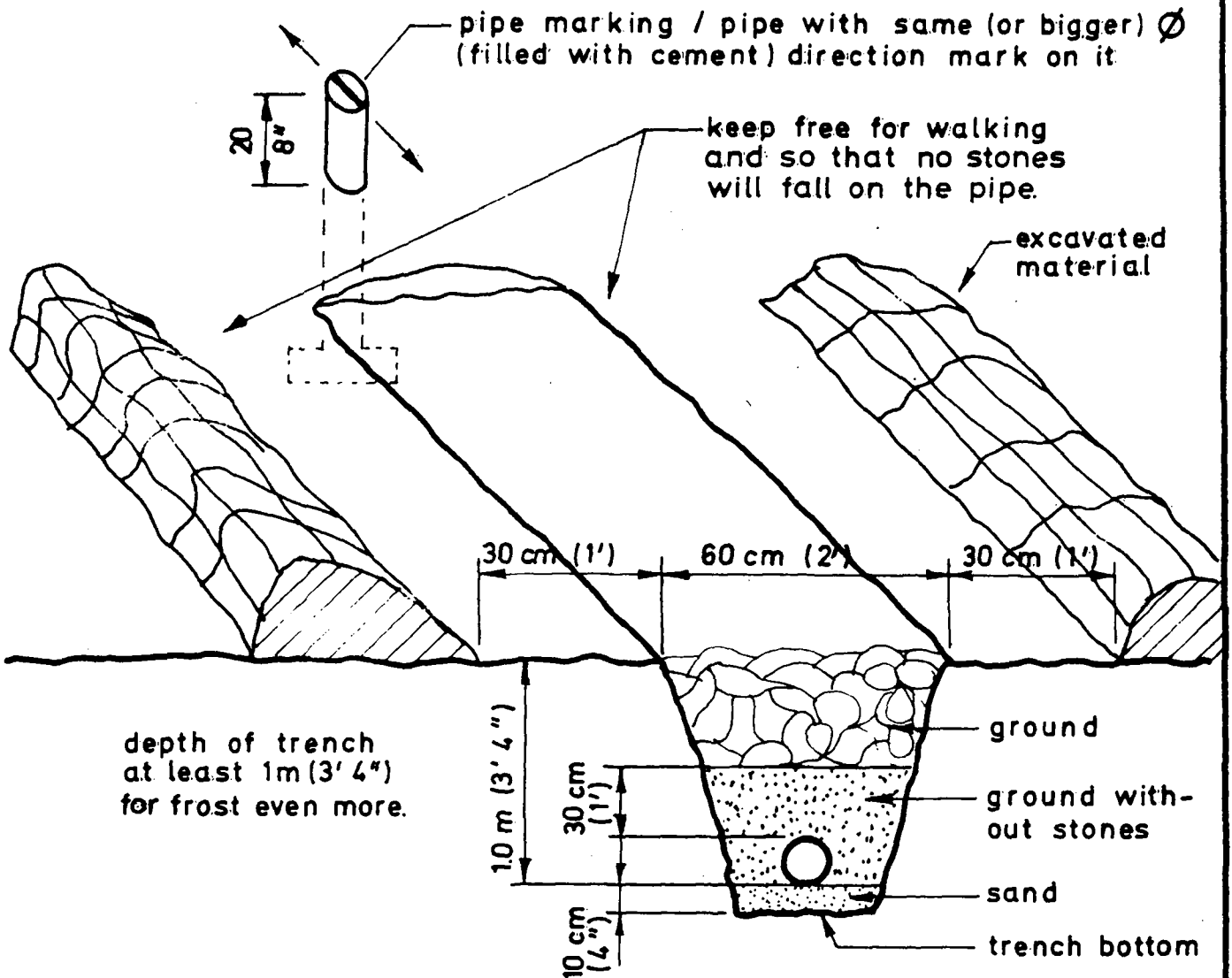


LOSS OF HEAD



PIPELINES

Never bring water to a place, before the waste water can be brought away from the faucets.  
 (MOISTURE brings insects and illness).



depth of trench at least 1m (3' 4") for frost even more.

Before refilling the trench: check if it's waterproof!  
 Make plan how the pipe lies.

Pipes should be in the ground, where they are protected against mechanical damage. The temperature also will be better.  
 The depth of trench should be at least 1.0 m (3' 4") otherwise there could be the risk that they will be dug out by the farmers for irrigation.

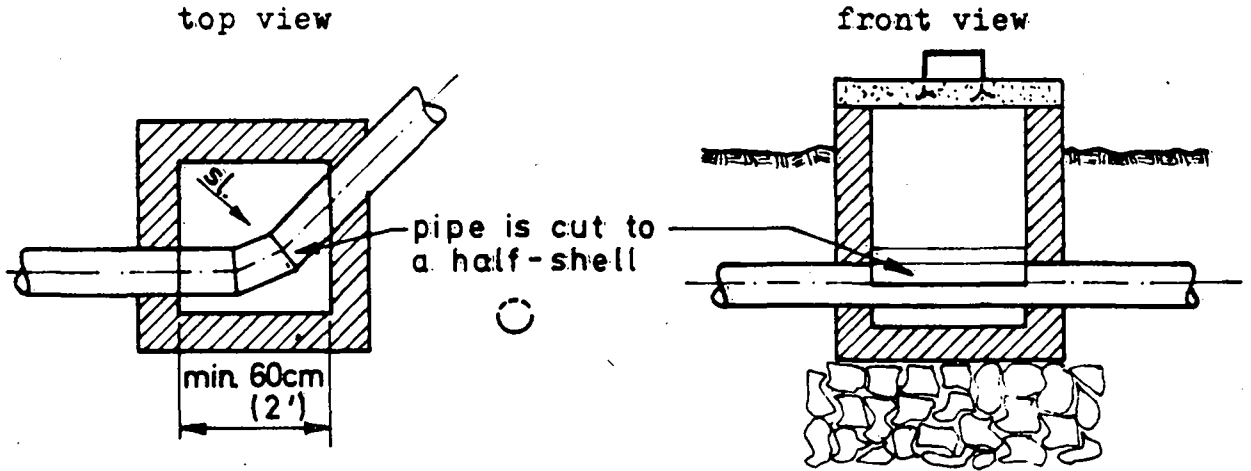
Don't let pressure in the pipeline, before the trench is filled up in the correct way. Otherwise remains the risk, that it will never be done.

Always look through the pipes before you install them, and close the open ends and if it is only for a few minutes!

WP 4 = Working pressure 4 kg/cm<sup>2</sup>. Good for a pressure of 40 m head.  
 ND 6 = Nenndruck (nominal pressure), working pressure = 6 kg/cm<sup>2</sup>

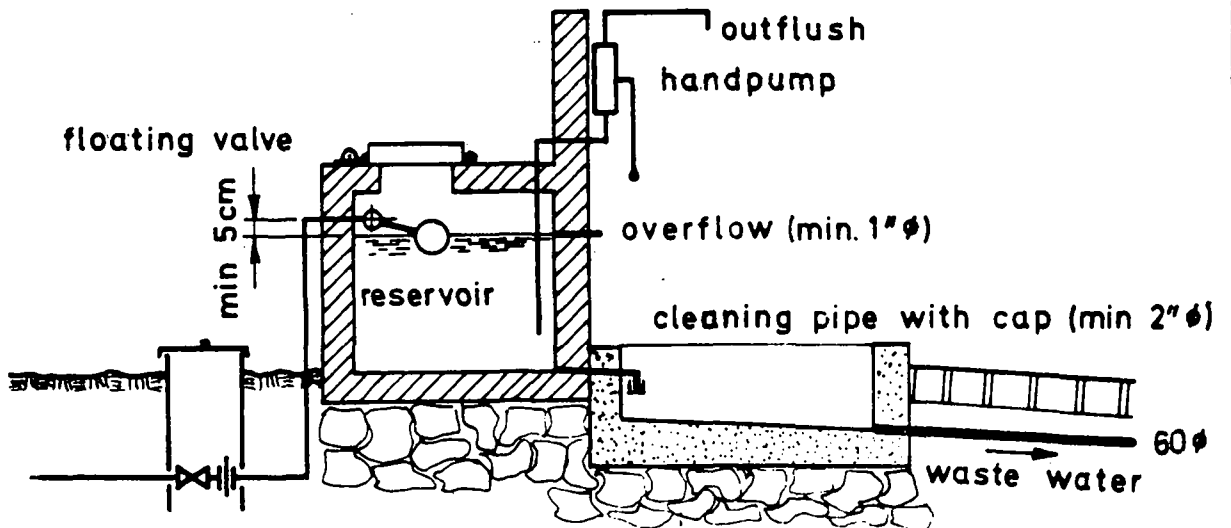
Manhole

By changing the direction in the ground, make always big bends.  
 The best solution (by low pressure distribution only) is a manhole.  
 For cleaning reasons and also for blocked pipelines.  
 Pipelines in the ground should have a diameter from at least 5/4".  
 (Exceptions: branchline to standpipes).



Standpipe with reservoir and pump

Water shortage remains a good possibility, as shown. Shortage because there is not enough water, or because the people don't close the valve.



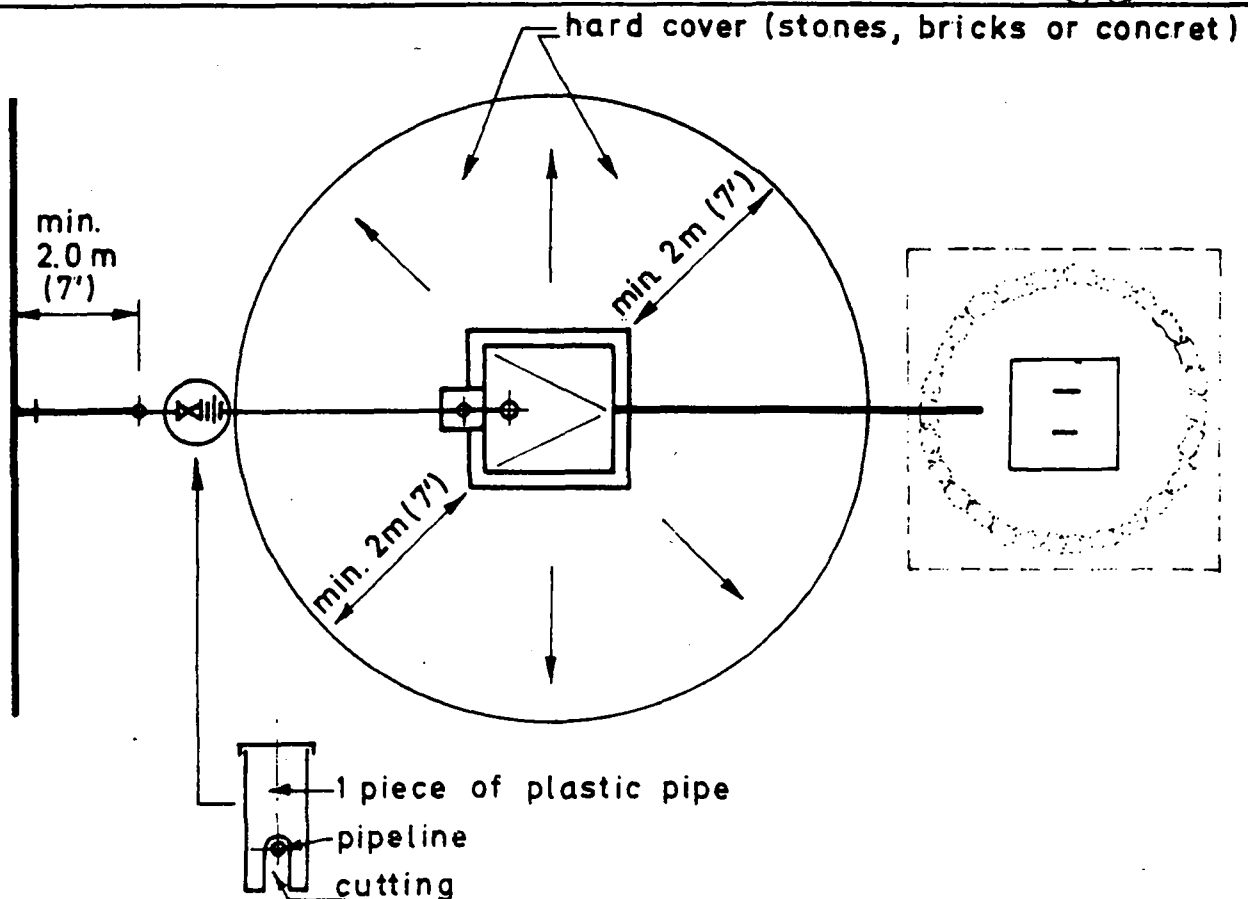
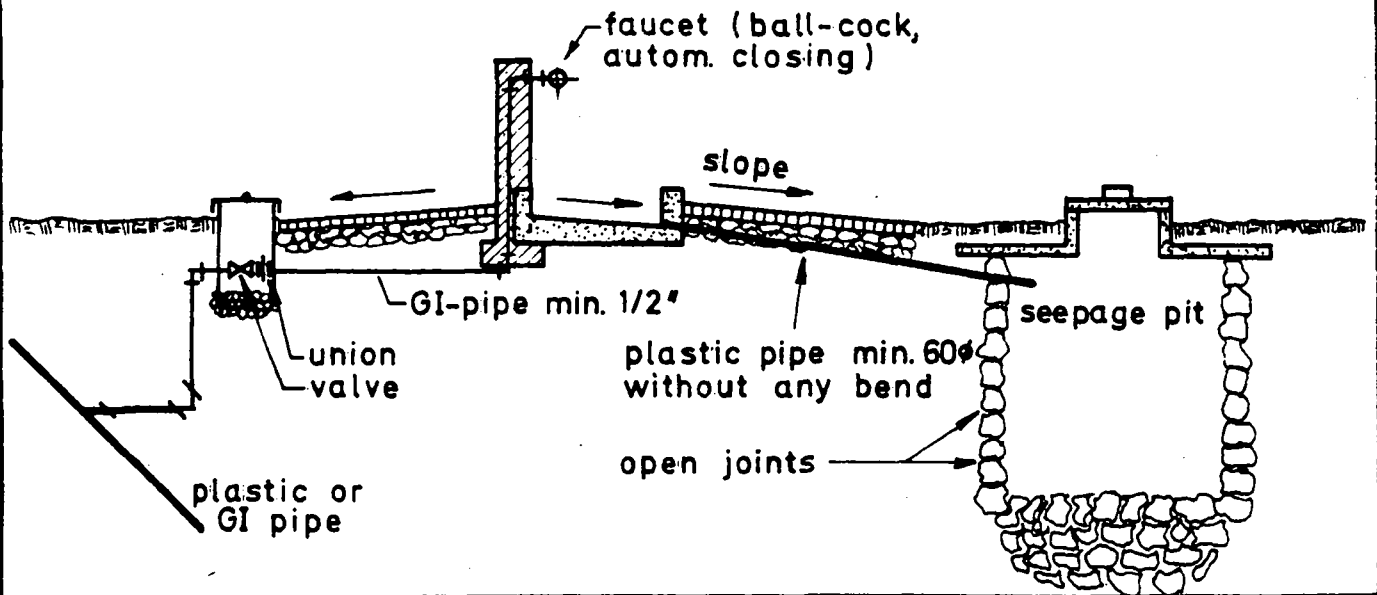
for standpipe construction see special page!

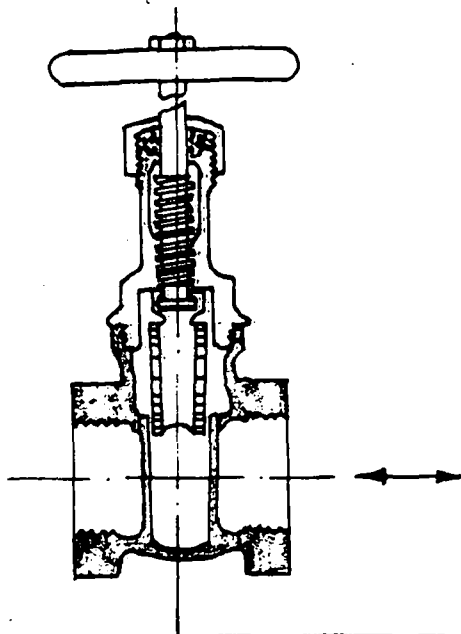
Standpipe

A bad water tap site makes bad situations worse!

Take **great care** for the place itself, and the place around. The **waste water outlet** is absolutely obligatory. (Moisture brings dirt, insects and sickness).

Don't open the system before every work is finished, the risk that it will not be done is very possible.





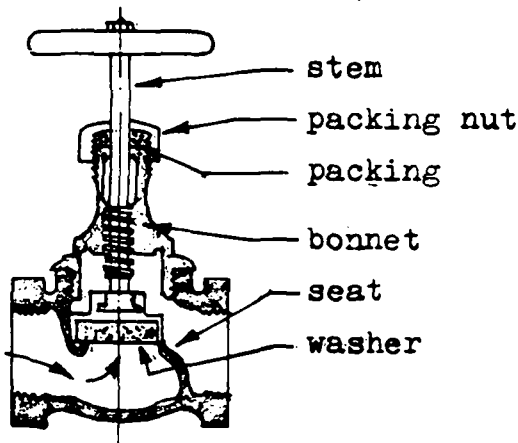
Gate Valve

The seat openings are usually of the same  $\phi$  as the inside of the pipe. They have a very little resistance to the flow of water, when the valve is completely open.

Use: in main pipelines, before the faucets.

Where watertightness is not so important.

No use: as outflush valve. (to high speed in the pipeline). Therefore take the faucet type.



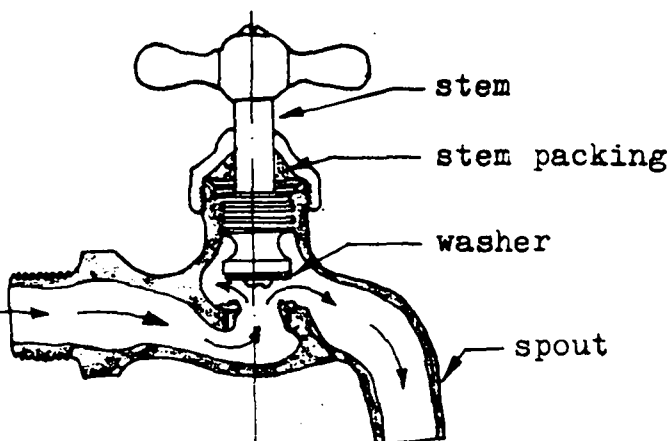
Globe Valve

This valve has to be installed with the water pressure under the valve seat.

A globe valve can be repaired and is watertight. But the friction loss is quite high.

Use: for smaller  $\phi$  only.

No use: as outflush valve by reservoirs.

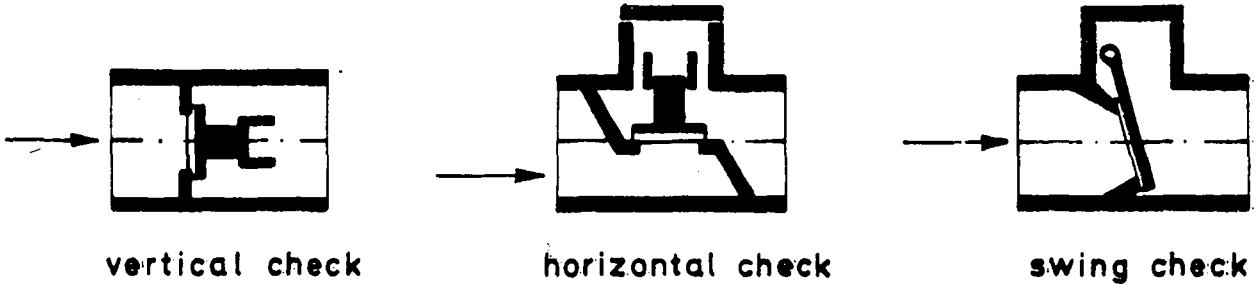


faucet (stop cock)

The faucet close against the water pressure. When it is open, the passage is relatively free for the water.

The spout may or may not be threaded for hose connection.

Nonreturn Valves



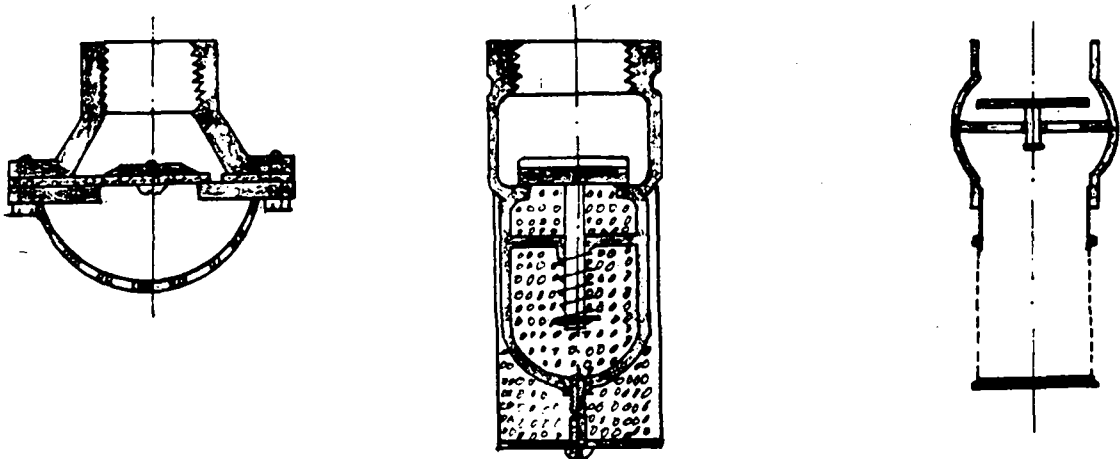
vertical check

horizontal check

swing check

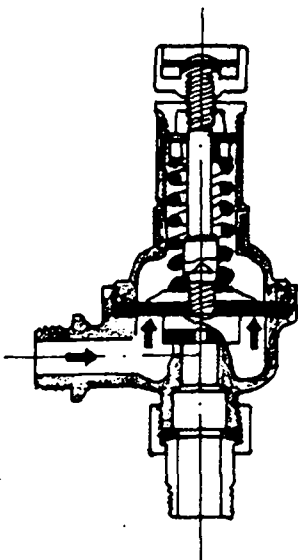
Use: Where the water has to stay in the pipe.  
 By pumped gravity systems and by installation  
 of hot water reservoir (boiler), but then with  
 safety valve only!

Caution: The check has to be installed with the water pressure  
under the seat!



Use: On the end by suction pipes (pumped systems)

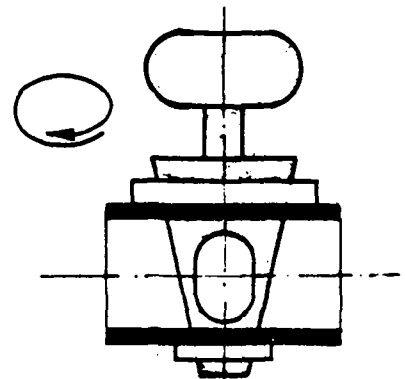
Foot Valves



Safety valve

Use: With danger of  
 overpressure.  
 Necessary by hot-  
 water reservoirs.

Caution: verify  
 the flush direc-  
 tion of the water.  
 No valve between  
 boiler and non re-  
 turn valve!



Plug valve

Use: for gas only.  
 Not watertight and  
 danger of water-  
 hammer+= overpress.

G.I. pipes (galvanized iron pipes)

Use: inside buildings, (high mechanical resistance).  
electrical conducting

- |   |  |
|---|--|
| + mechanical resistance                                     | - high friction<br>(loss of head = reduction of pressure and quantity) |
| + fittings available  | - no possibility to make the fittings (about the galv.)                |
| + good for small diameters                                  | - no resistance against chemical corrosion (rust)                      |
| + few extension   | - pieces up to 6 m (20')<br>(= many joints).                           |
| + good connection with cement<br>(after removing the galv.) | - without flanges, only good joints up to the $\emptyset$ of max. 2"   |
|   | - quite heavy  |

Never put union's (or flanges) in ground or wall. (Without revision possibility = manhole).

Painting in ground and in walls is necessary as protection against corrosion (danger of rusting).

By using 6.0 m pieces (20') cut off the half length of the thread (with a hacksaw) and cut a good thread.

No bends of G.I. pipes without using fittings. (Otherwise the galvanization will split off = risk of rusting).

$\emptyset$	outside $\emptyset$ in mm	appr. weight/ m	length of thread (unsrew-length) in mm
1/2	21.3 mm	1.2 kg	13 mm
3/4	26.9 mm	1.5 kg	15 mm
1"	33.7 mm	2.4 kg	17 mm
1 1/4	42.4 mm	3.1 kg	19 mm
1 1/2	48.3 mm	3.6 kg	19 mm
2"	60.3 mm	5.0 kg	24 mm
2 1/2	76.1 mm	6.5 kg	27 mm
3"	88.9 mm	8.4 kg	30 mm

Pressure: (depends on the quality)

1/2 - 3/4      appr. 25 kg/cm<sup>2</sup>

1" - 4"        appr. 16 kg/cm<sup>2</sup>

### G.I. pipes / Thread cutting

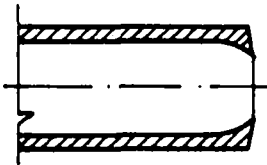
1. Check the quality of the pipe; (correct weld seam, proper galvanization, diameter accurate).
2. fix the pipe in clamp.
3. cut the length and after the thread. (Never cut threads without oil).
4. check the length of the thread.
5. clean it from oil and steel splitter.
6. put hemp and jointing paste (putty or animal grease)

Checking: If the thread is properly cut, it should be possible to screw appr. 65% of the threaded portion into a fitting by hand.

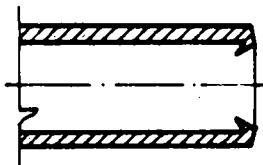
Plumber-threads are conical. The fittings will spoil, if they are unscrewed the whole length; about 2 turns of the thread should remain visible. Protection against rust with paint.

Caution: Gate valves, globe valves and similar items should be easily removable for overhaul or replacement, without dismantling much of the line. For this purpose long threading, unions or flanges should be fitted close to such parts.

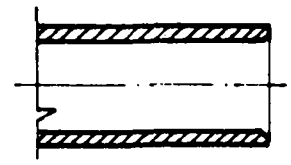
Cutting pipes with pipe-cutter, requires that the pipe be reamed for burring. Better to use only hacksaw for cutting.



The burr made  
by a pipe cutter



Improper reaming



Pipe properly  
reamed.

### Watertight joints on threads.

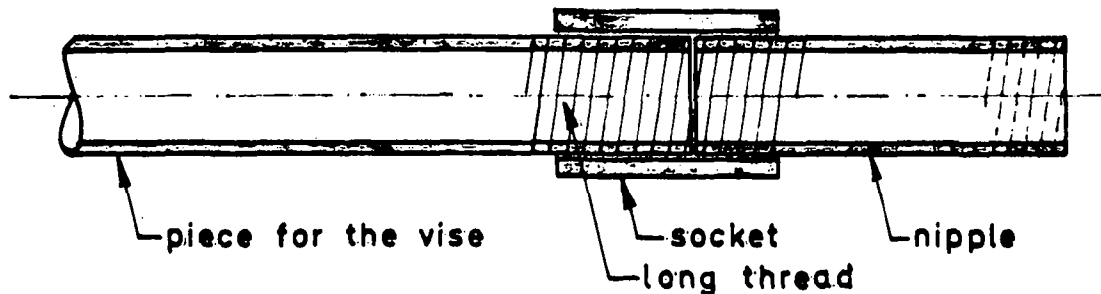
Use only dry hemp (candle wicking) and non-poisonous joint paste, (putty, or animal grease). Paint as joint paste is not recommendable, because it dries hard

1. Turn hemp in clockwise direction, starting at the beginning (end of the pipe) of the thread, covering the entire thread with hemp.
2. Put pipe joint paste on the hemp of the thread, check that no hemp, oil or joint paste is inside the pipe.
3. Start the fitting on the pipe by hand and tighten with the pipe wrench until reasonably tight. If turned too tight, the fitting may stretch or crack. (2 turns should remain visible).  
Use a small wrench on a small pipe.
4. Cut off the hemp with an old hacksaw blade, by moving anti-clockwise. Paint the visible part of the thread.



### G.I. pipes / Nipple cutting

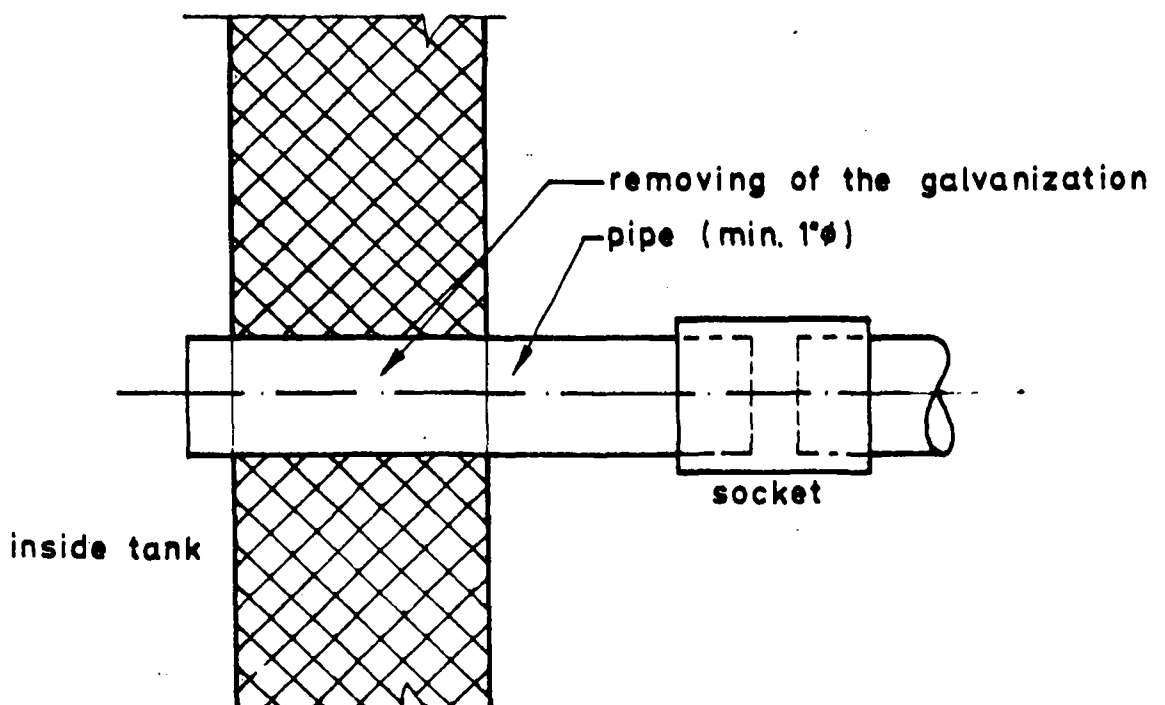
1. Cut thread at the end of a pipe.
2. Mark the length of the nipple and cut it off.
3. Cut the end on the other end of the nipple.  
As it is too short to be chucked in the vise directly, the nipple must be extended. Use a suitable pipe with a socket at the end. On these must be long threading; important: both ends of the pipe must touch inside the socket. Cutting nipple in this way is only possible for smaller diameters.



### Good connection to concrete tanks

can only be done with G.I. pipes. For really good connections it is important, that the G.I. pipe is fixed in the same time as the wall will be build up. (Otherwise the joints can leak).

Caution: The galvanization must be removed!

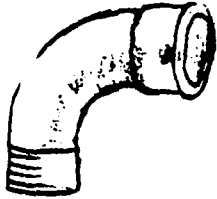


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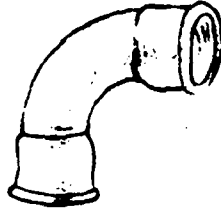
**GALV. FITTINGS**

**4. 4**

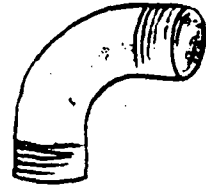
**BEND NO. 1**



**BEND NO. 2**



**BEND NO. 3**



**BEND NO. 42**



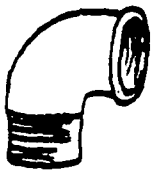
**BEND NO. 52**



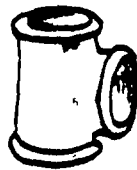
**ELBOW NO. 90**



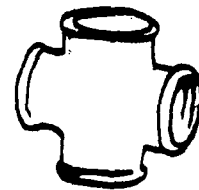
**ELBOW NO. 92**



**TEE NO. 130**



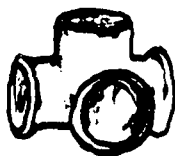
**CROSSES NO. 180**



**SIDE OUTLET  
ELBOWS NO. 221**



**SIDE OUTLET  
TEES NO. 223**



**REDUCING SOCKETS  
NO. 240**



REDUCING BUSHES  
NO. 241



SOCKET NO. 270  
L/R NO. 271



HEXAGON NIPPLES  
NO. 280



PLUGS NO. 290



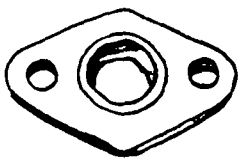
CAPS NO. 300



BACK NUTS NO. 312



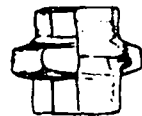
FLANGET OVAL  
NO. 320



FLANGET ROUND  
NO. 321



UNION NO. 330



NIPPLE NO. 530



NIPPLE NO. 532



## Plastic pipes (H D P + P V C)

Use: for cold water only, pipelines in the ground.  
no electrical conducting.

Pipes and fittings made from plastic offer many advantages. They have excellent chemical resistance which, combined with smoothness of bore, eliminates build-up of scale and gives good flow characteristics which remain constant throughout their working life.

Being odourless and tasteless, they are suitable for conveying drinking water and many food products; they have good abrasion resistance and weathering qualities, and afford good thermal and electrical insulation. Plastic pipes are light and clean to handle, and may be easily joined.

The excellent chemical resistance of plastic pipes makes them especially suitable where pipelines are exposed to the risk of external corrosion.

### Points to remember about expansion and contraction.

A pipeline should be allowed to expand and contract freely.

Wherever possible, expansion and contraction should be taken up by changes in direction.

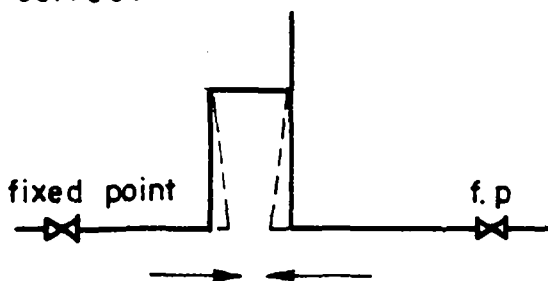
Careful positioning of fixed points will enable the direction of expansion and contraction to be controlled.

Expansion loops may be used, but they must be large enough to give adequate flexibility. (at least 2.0 m, resp. 7').

Valves and heavy components must be independently supported so that no stresses are imposed on the pipeline.

Where pipework incorporates pumps or other machinery, and there is a possibility of excessive vibration, it may be advisable to isolate the source of the vibration by means of flexible connections.

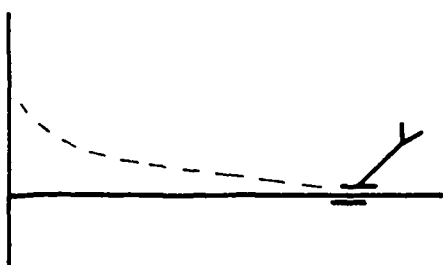
correct



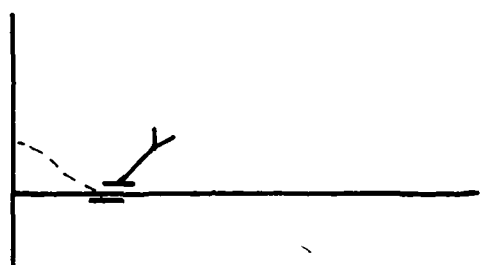
incorrect



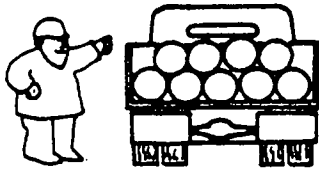
correct



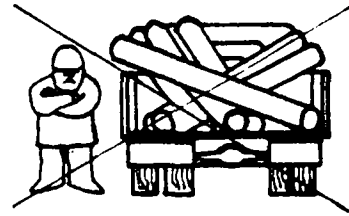
incorrect



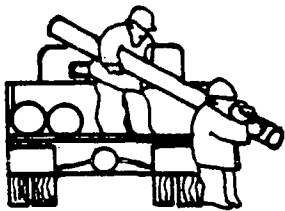
Transport and Storage



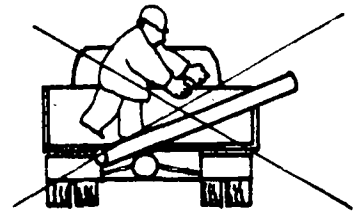
Lay pipe in the truck in an orderly manner and supported along its entire length.



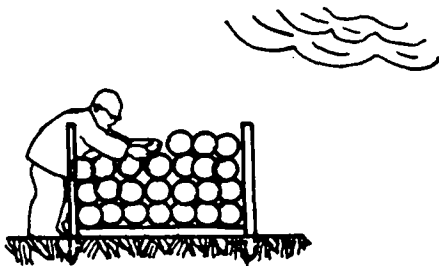
Don't mix up



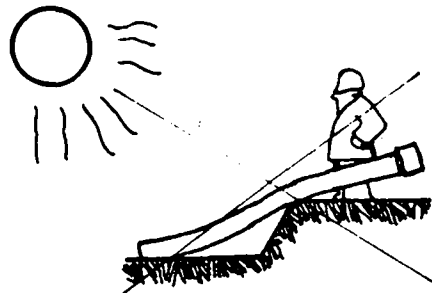
carry the pipes,



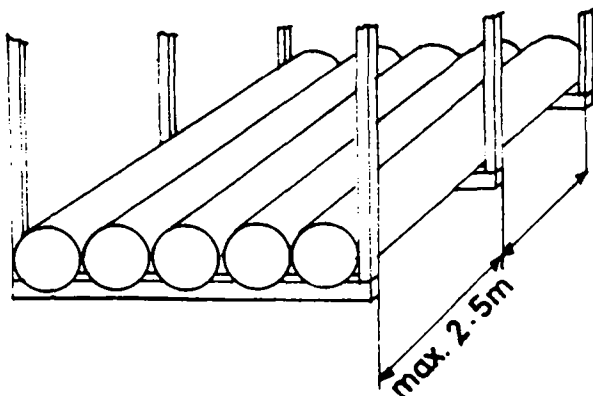
Don't throw-down



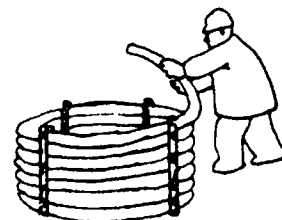
storage on square timber, in the shadow, in a straight line



Don't place on edges, or in sunshine (more than 30 °C (more than 86 °F)



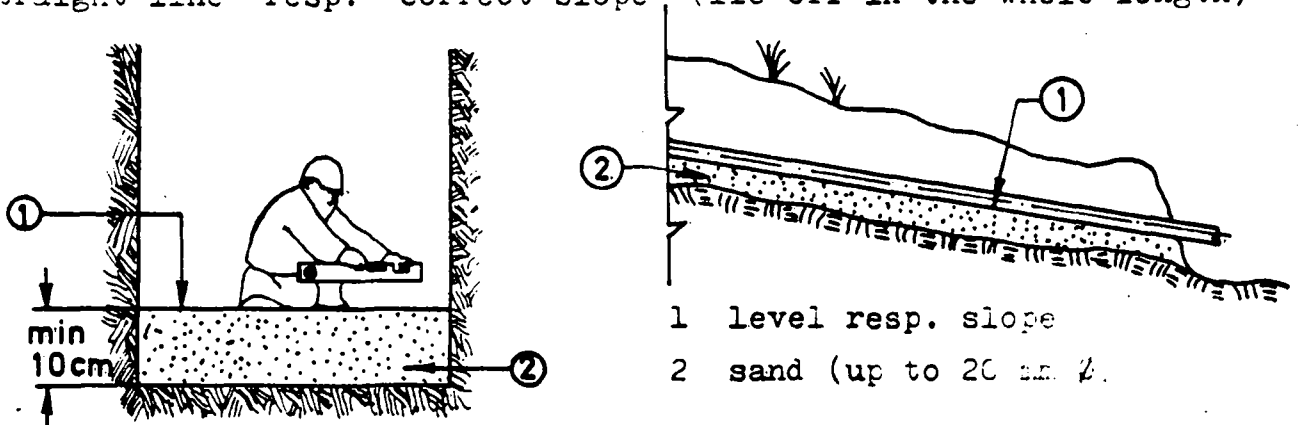
HDP pipe coils



should be laid horizontally, and in the shadow.

Preparation of trenches and laying the pipes

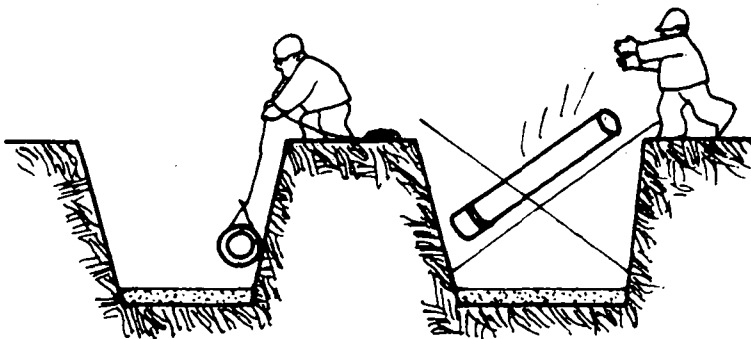
straight line resp. correct slope (lie off in the whole length)



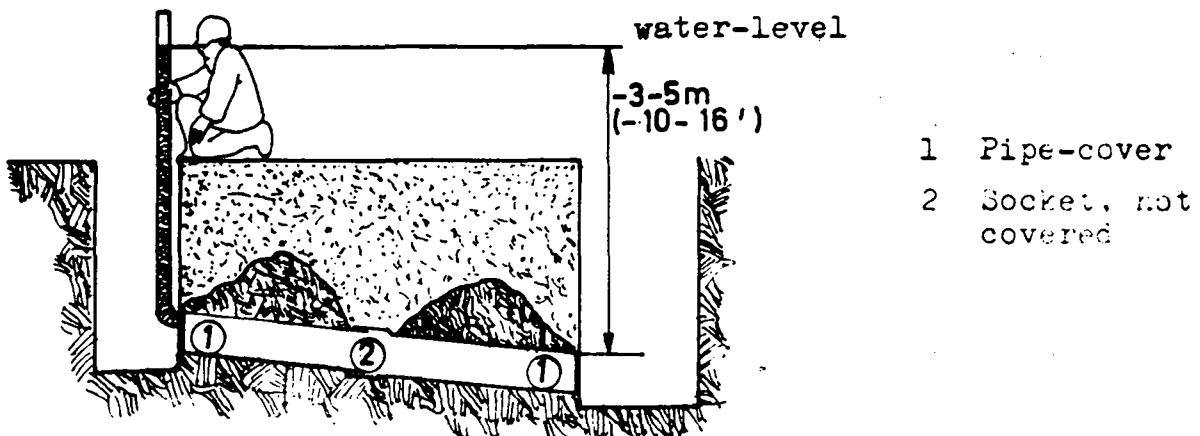
- 1 level resp. slope
- 2 sand (up to 20 cm 4)

(very important by PVC pipes, fragility)

handle the pipes with care (PVC = breakable)

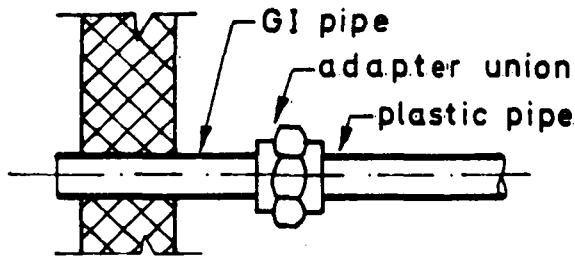


check the watertightness (before covering the trench)

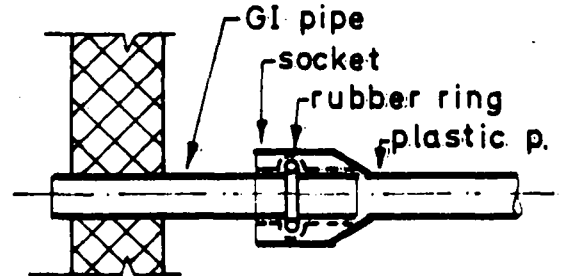


## CONNECTIONS BETWEEN GALV. PIPES + PLASTIC PIPES GI : PVC/HDP

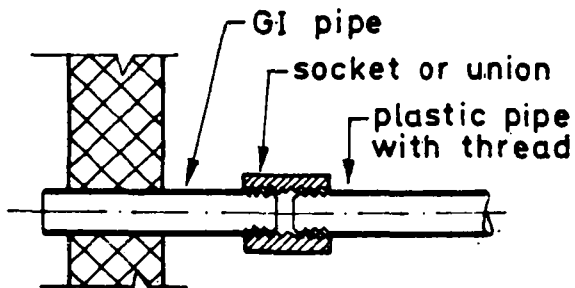
The best solution : adapter union



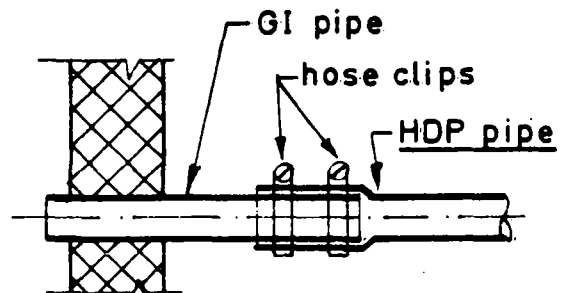
with rubber ring.  
ev. heating = draws together



Cut thread on plastic pipe.



By H.D.P pipe only



About connection to concrete walls see special description.

Screwed joints on plastic pipes

The outside diameter of the plastic pipes must be according to the GI pipes. Because screwed joints necessitate the use of a thick walled pipe; the overall cost of the installation will be higher than for a similar one resp. for low pressure (by PVC pipes with solvent cement joints).

The length of the threads should be according to the GI threads. If the thread on the pipe has been cut properly, it should be possible to screw the fitting on by hand for about two-thirds of the thread length.

Points to remember about screwed joints on plastic pipes.

1. New chasers should be used and retained for threading plastic pipes.
2. The full depth of thread should be cut in one continuous operation.
3. Lubrication of the chasers is not necessary. Oil strictly prohibited.
4. Care should be exercised to ensure that undue strain is not applied when making a threaded joint.
5. The normal type of wrench should not be used, but special tools of strap type are recommended.

PVC pipes

**Name:** PVC is a short sign for Polyvinylchlorid

**Density:** 1.4 kg/dm<sup>3</sup>

**Colour:** gray (normally)

**Use:** in the ground, for long distances  
for cold water only (below 60 °C = 140 °F)

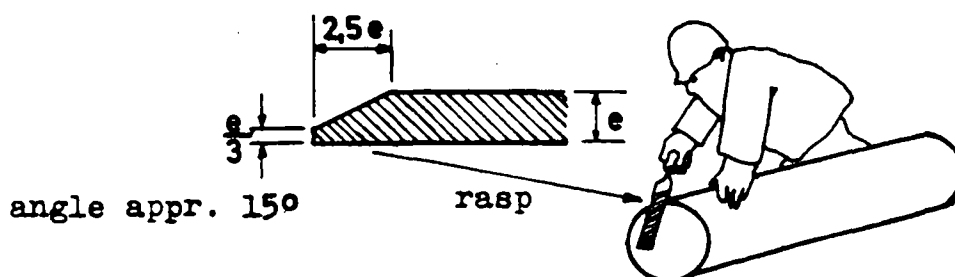
**Installation:** Generally apply the same rules as given for G.I. pipes (galv. pipes).  
PVC must be installed free from stress and not in freezing areas.  
The clamping-distance is approximately ten times the pipe diameter.  
Handle the pipes with care, avoid shocks.  
Don't paint the pipes after installing. Some paints will destroy the PVC material.

- |                            |  |
|----------------------------|--|
| + connection with adhesive | - breakable<br>(few mechanical resistance)   |
| + light in weight          | - difficult to make fittings   |
| + good for make sockets    | - length of the pipes only<br>up to 6.0 m (20')  |
| + need few tools           | - welding only with special<br>tools (needs electricity)                                     |
| + low friction loss        | - adaption to terrain is<br>limited. The trench bot=<br>tom must be very well pre=<br>pared. |
|                            | - no direct connection with<br>cement.   |

Preparing of a spigot end

Mark the length with a soft pencil on the PVC pipe and cut it with fox saw (also hacksaw) and remove internal burrs.

slightly chamfer outer edge of pipe (appr. 15° to pipe axis)





### PVC solvent cement joints

The cement creates a chemical bond between the pipe and the fitting. It is a simple and efficient method of jointing, and because it is also permanent it is important to use the correct technique which is as follows:

1. Cut the pipe end square, and remove internal burrs.
2. Degrease joint surfaces of pipe and fitting with cleaning fluid, using absorbent paper.
3. Slightly chamfer outer edge of pipe (appr.  $15^{\circ}$  to pipe axis).
4. Roughen joint surfaces, using clean emery cloth or medium glass-paper, and clean again.
5. Mark on the spigot end the length of the socket. (With a soft pencil).
6. Using a brush, apply an even layer of cement to both fitting and pipe in a lengthwise direction, with a thicker coating on the pipe.
7. Immediately push the fitting (or the pipe end with the socket) on to the pipe without turning it, until it reaches the reduced portion of the socket. Then turn pipe at least  $1/4$  of a full turn. Keep them in this position for a short while, (10 - 20 seconds). Now remove the surplus cement.
8. Leave undisturbed for five minutes, then handle with reasonable care.
9. Allow 8 hours before applying the full rated pressure.  
For lower pressure, allow one hour per  $1 \text{ kg/cm}^2$  ( $15 \text{ lbf/in}^2$ )  
For example  $3 \text{ kg/cm}^2$  ( $45 \text{ lbf/in}^2$ ) would require 3 hours drying time.

### PVC points to remember about cemented joints

1. Before applying cement, the mating surface must be absolutely clean and dry.
2. For sizes 3" and above, two persons are required to apply cement simultaneously to pipe and fitting.
3. The tin of cement should be closed immediately after use, as the solvent evaporates quickly.

Caution: Solvent cement is inflammable, and there should be no smoking in the working area. The cement should be used in well ventilated conditions only.

PVC sockets

1. prepare a spigot end (according description).
2. Mark the length of the socket (on the pipe for the socket). The dept of a socket is about one time the outside diameter of the pipe.
3. Heat the end of the pipe with a soft flame (or in hot oil) until it is soft and rubber like. While the pipe is soft, see that the two pieces of pipe are joined straight in line, and then cool them with water. Only then, when it is cool, remove the pipe.

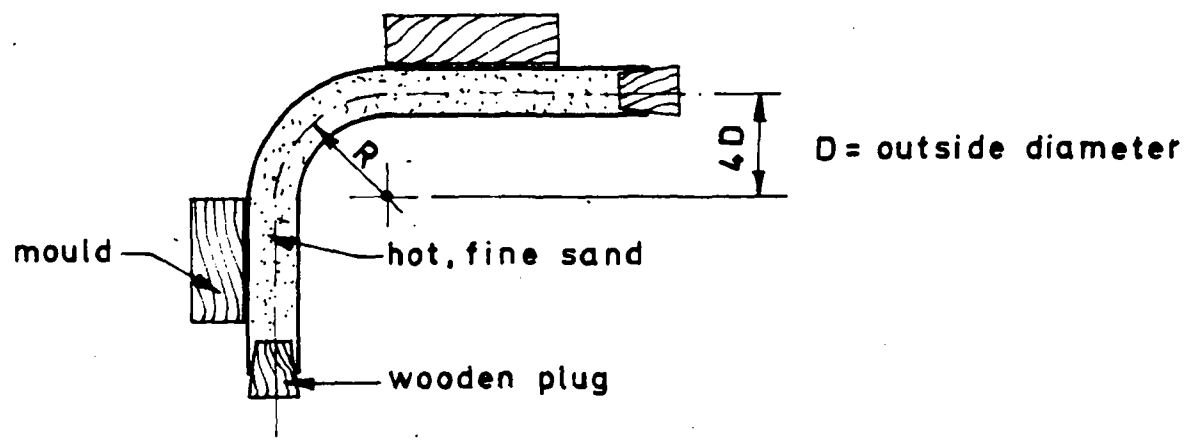
PVC tee-connections

The pieces and other fittings are (maybe) available in the market.

PVC bending

By applying heat, PVC pipes may be easily bend to any angle.  
 For bending without sand use a bending radius from at least 8 times the outside diameter.  
 For bending with sandfilling use a bending radius from about 4 times the outside diameter.

1. For small bends: close one end of the pipe with a wooden plug.
2. Fill the pipe with hot, fine sand (warming with a flame). Compress the sand inside the pipe while knocking the pipe outer-walls with a wooden stick.
3. Close the other end of the pipe also with a wooden plug.
4. Heat the pipe with a soft flame, while turning the pipe, and bend over the mould.
5. Cool with water.
6. Prepare spigot-end or/and socket.



HDP pipes

**Name:** HDP is a short sign for High density polyethylene.

**Density:** 0.9 kg/dm<sup>3</sup>

**Colour:** black (normally)

**Use:** in the ground, for long distances (coils)  
for cold water only (below 60 °C = 140 °F)

**Installation:** Generally apply the same rules as given for GI pipes (galv. pipes)  
HDP should be installed free from stress.  
The clamping-distance is approximately ten times the pipe diameter.  
Don't paint the pipes after installing. Some paints will destroy the HDP material.

- |  |  |
|--|--|
| + connection with welding plate                    | - Adhesion is not possible   |
| + possible to make fittings<br>(Tee, bends)        | - Connection with sockets<br>is difficult without<br>special fittings. |
| + available in coils<br>(up to 100 m, 330')        | - no direct connection<br>with cement.                                 |
| + light in weight<br>(transport cost)              | - easy to make hole in it.<br>(therefore deep trenches)                |
| + need few tools<br>(no electricity)               |  |
| + good chemical resistance                         |  |
| + low friction loss                                |  |
| + flexural strength<br>(resist breakage and frost) |  |
| + good adaption to terrain                         |  |
| + incrustation-free smooth<br>internal surface.    |  |

HANDLING, LAYING AND JOINTING COILED POLYETHYLENE PIPEPipe Coils

Polyethylene pipe can be supplied in coils in a size range 3/8"-4" and in some instances 6" diameter. Coil lengths of 150 m (492 ft) in sizes 3" and 4" are in common supply. Longer coiled lengths of up to 2000' of 3" and 4" diameter pipe can be supplied on special drums.

When Polyethylene pipe is coiled this is done at factory ambient temperature of approximately 25° centigrade (77° F). The pipe, which is extruded as a straight pipe is mechanically wrapped round a coil former and bound together into a rigid transportable coil. When the binding is cut from the coil, the pipe will tend to revert to a straight pipe, and care should be exercised to control this movement on pipe diameters 2" and above as the uncoiling force can be of considerable magnitude and could cause injury to those handling the coil.

When uncoiling pipe, the bound coil should be stood vertically on its circumference. The outer free pipe end should be positioned at the bottom of the coil and as soon as it is cut free from the coil, this end should be anchored to the ground with a stake or metal hoop. The coil should now be rolled out away from the anchored end until the entire coiled length is unwound.

The ends of the coil pipe, though tending to straighten themselves, will, for some time, retain a degree of curvature. It will facilitate jointing if adjacent pipe ends are arranged so that this curvature is towards each other.

The ends of Polyethylene pipe when cut, after extrusion will tend to reduce in diameter slightly over the last 2" or 3" of the pipe. This short section of pipe should be cut off, and in doing so the pipe end cut truly square.

Alignment for Butt Welding

When jointing pipe by the butt weld technique, it is essential that the pipe ends meet truly square and mate together without external restraint. Bearing in mind that these ends will both be curved, the alignment of the joint may be achieved either in the form of a semi-circle, where the curvature of the pipe ends is in the same direction, or in the form of a large letter 'S' if the curvature of the pipe ends is contrary. Time spent in achieving exact alignment is time well spent as the subsequent jointing will be a very simple matter indeed.

Storage

Polyethylene pipes should not be stored along side fertilizers, pesticides, insecticides and chemical compositions such as these, otherwise, those pipes are liable to develop cracks.

Welding

Only when good alignment has been achieved should the welding process be attempted, the procedure for which is as follows:-

1. Assemble pipe ends in clamps leaving approximately 2" of pipe projecting inwards from each clamp.
2. If pipe ends have not previously been squared, then square off using a fine toothed wood saw. Again check alignment.
3. Complete trimming of pipe ends using the trimming tool. This achieves both a very clean and square trim and also exposes a perfectly new face for the weld. Care should be taken that the trimming of the pipe ends is complete over the entire pipe circumference. After trimming nothing should be allowed to touch the newly exposed faces.
4. Remove trimming tool and again check the joint for neat join and true alignment. At no point on joint should there be a gap of more than 0.5 mm (1/64").
5. Check temperature of heating tool with heat crayon, which should be 210°C (+10°, -5°C) or 410°F (+50°, -41°F). Insert heating tool between pipe ends and adjust pressure of pipe ends on heating tool. Times and pressures for heating are given on the attached Chart.
6. Remove heating tool and without delay bring pipe ends into contact under pressure and leave under pressure, undisturbed until weld has cooled. Again welding pressures and cooling times are given on the attached Chart. The actual pressures can be read on the graduated pressure adjustment screw.

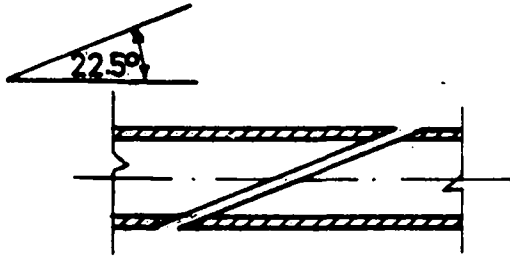
Indication of a good joint is given by the uniformity of the bead on the outside of the pipe over its entire circumference.

Unevenness of this bead is an indication of poor alignment and uneven pressure. The bead size should be approximately 2 to 3 mm thick on pipe size 2" to 6" i.d. Failure to achieve a bead on any part of the joint would be indicative of a suspect joint, and this joint should be cut out and re-made.

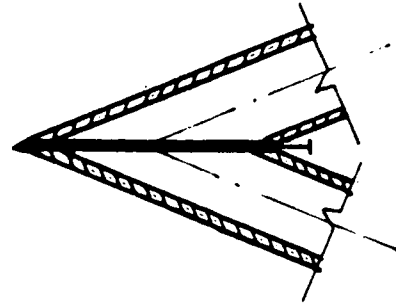
Welding of HDP pipes, pressure for about 30 seconds

∅ 48 mm	ca. 9 kg	(20 lbs)
∅ 56 mm	ca. 10 kg	(22 lbs)
∅ 75 mm	ca. 18 kg	(40 lbs)
∅ 90 mm	ca. 20 kg	(44 lbs)
∅ 110 mm	ca. 30 kg	(65 lbs)
∅ 125 mm	ca. 40 kg	(88 lbs)
∅ 150 mm	ca. 55 kg	(120 lbs)

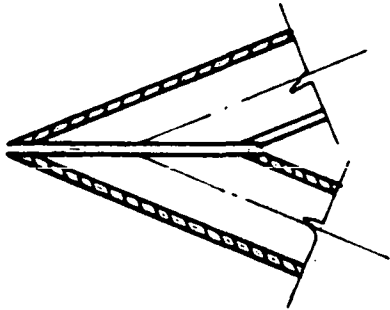
**IMPORTANT:** If the welding-plate is heated with a blow lamp or over a fire, then a teflon-paper has to be fitted over the plate after the heating before the welding can be done! Otherwise the quality of welding will be very bad.



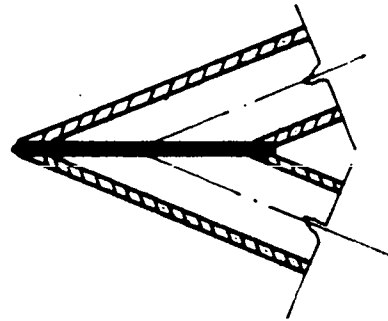
BRANCH 45°



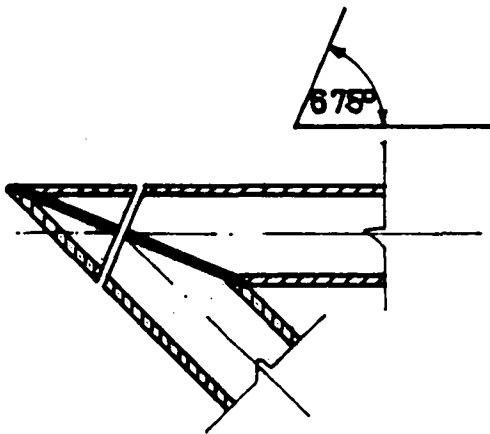
2. check



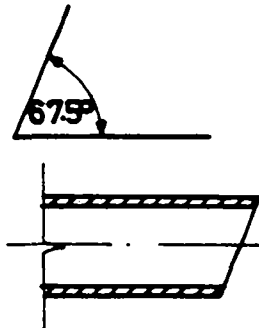
3. filing, check



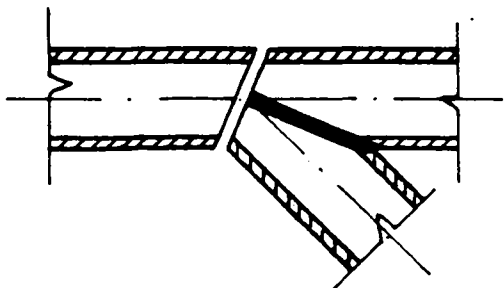
4. welding



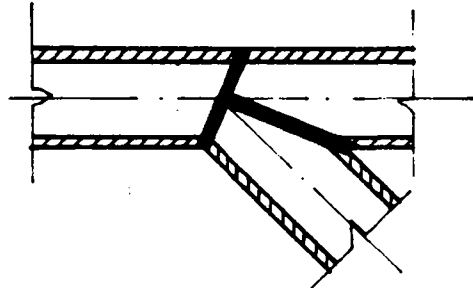
5. cut



6. cut another piece

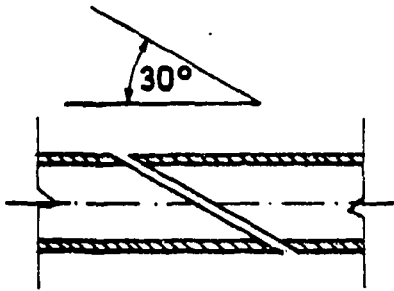


7. check, filing?

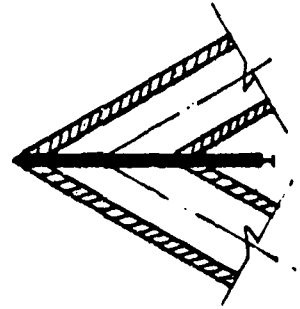


8. welding

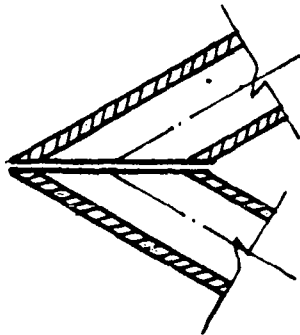
BRANCH 60°



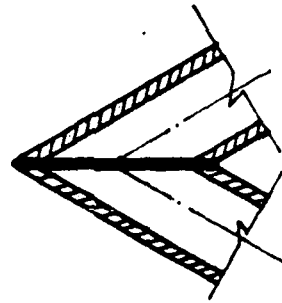
1. cut



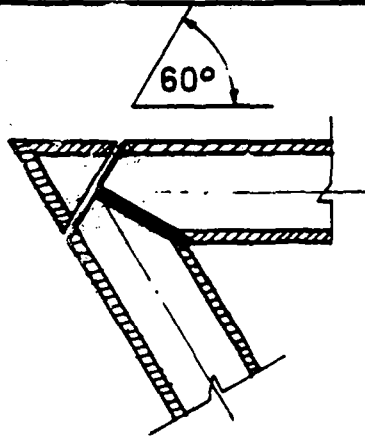
2. check



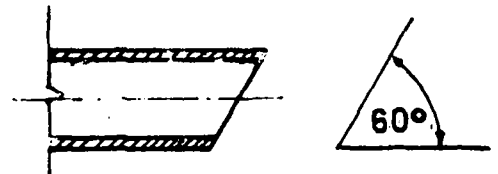
3. filing, check



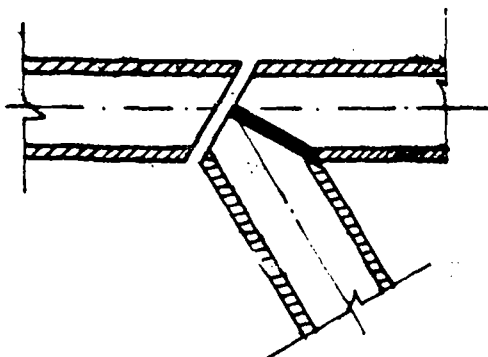
4. welding



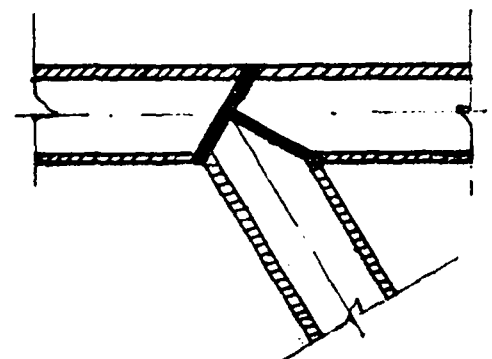
5. cut



6. cut another piece

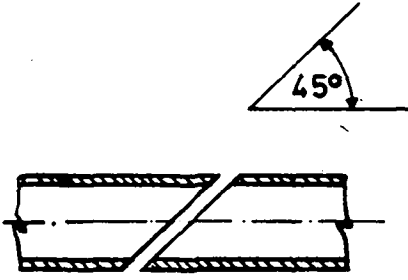


7. check, filing?

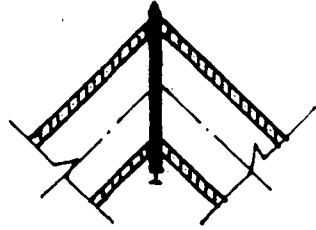


8. welding

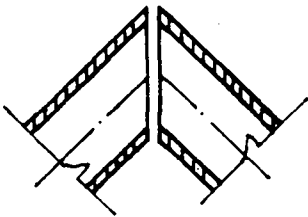
BRANCH 90°



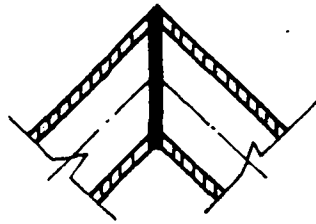
1. cut



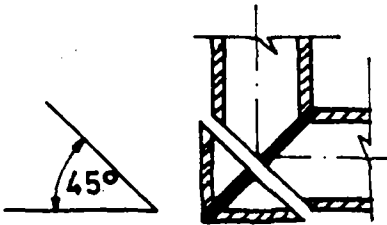
2. check



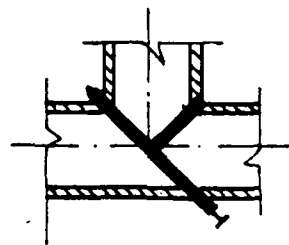
3. filing, check



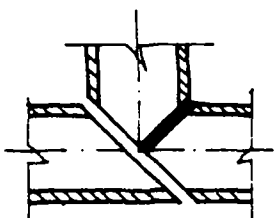
4. welding



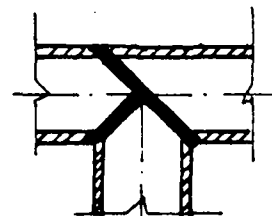
5. cut



6. cut another piece



7. check, filing

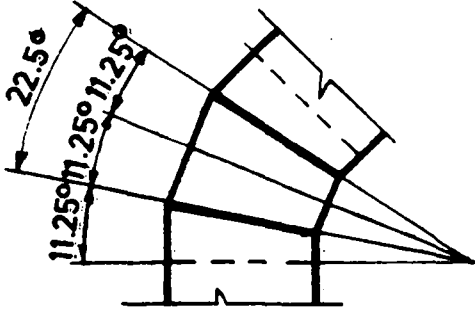


8. welding



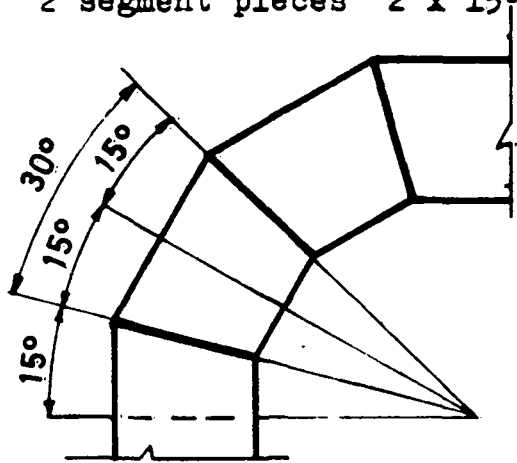
### Elbow 45°

2 pieces with  $11.25^\circ$  cut  
 1 segment piece 2 x  $11.25^\circ$  cut



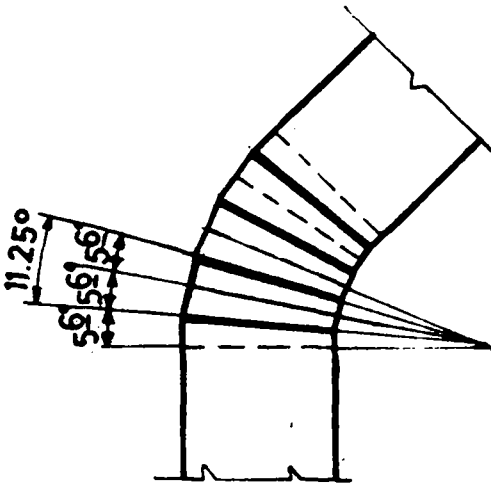
### Elbow 90°

2 pieces with  $15^\circ$  cut  
 2 segment pieces 2 x  $15^\circ$  cut



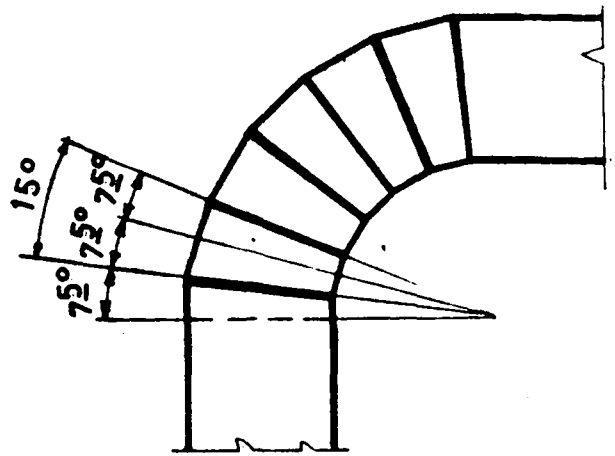
### Bend 45°

2 pieces with  $56^\circ$   
 3 segment pieces 2 x  $56^\circ$

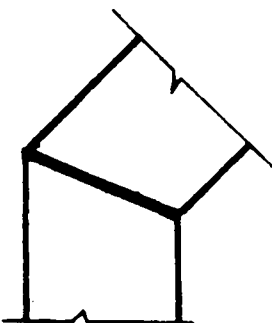


### Bend 90°

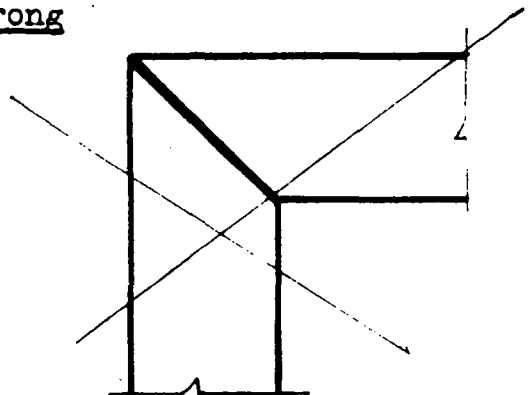
2 pieces with  $75^\circ$   
 5 segment pieces 2 x  $75^\circ$



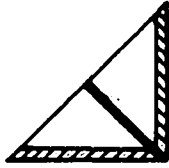
not recommendable



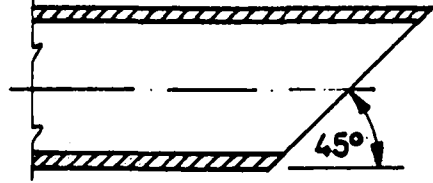
wrong



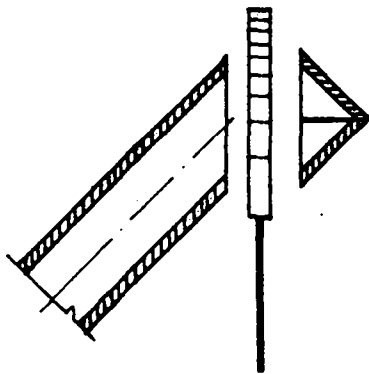
ENDCAP



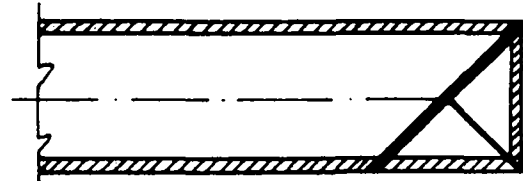
Take the remaining segment of a branch 90 °, from the same diameter as the main-pipeline (see page 7.6, No. 5)



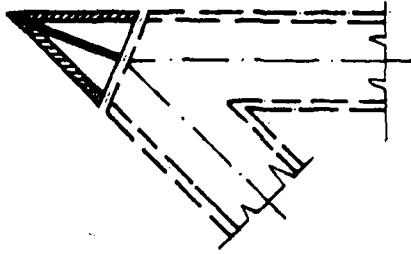
Cut an 45° angle on a straight pipe.



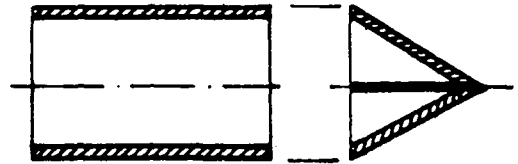
Heat both pieces on the welding plate



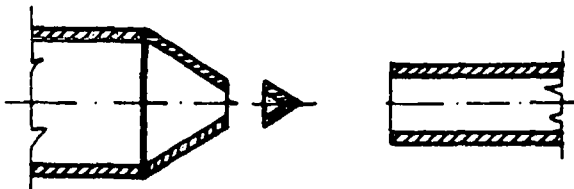
Press them together.



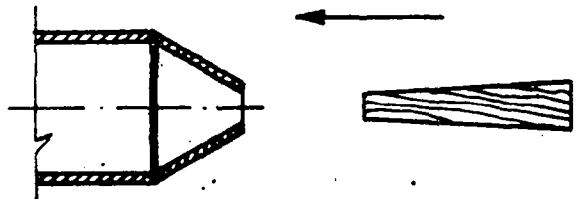
1. Take a segment of a 455 450 branch.  
(see 7.4, No. 5)



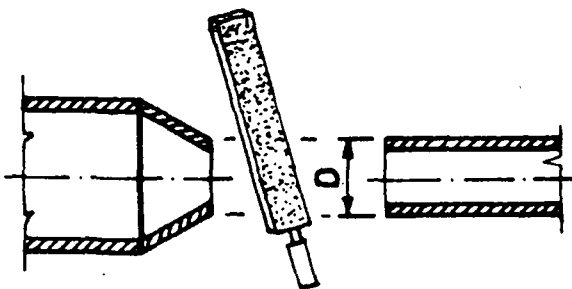
2. Check the diameters from the conical piece to the big diameter pipeline.



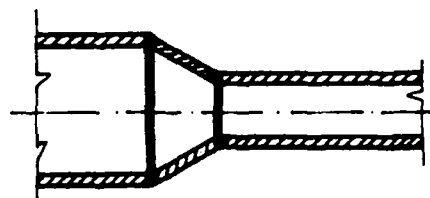
3. Weld the conical piece to the pipe with the bigger diameter.  
  
Cut of the pointed end, the segment has to be smaller than the diameter of the smaller pipe to be fixed.



4. Heat the end with hot air and push a conical piece into it.

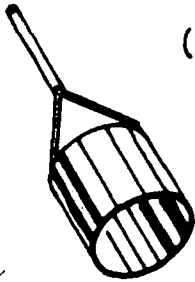


5. After the cooling, the diameter have to be made the same as the piece to be welded on it.



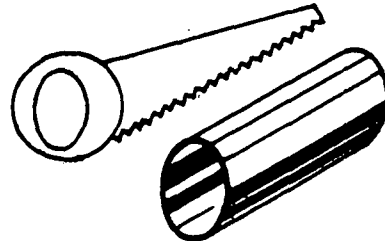
6. Heat both pieces on the welding plate and push them together.

**ENDCAP (+ 1st step for reducer - making)**

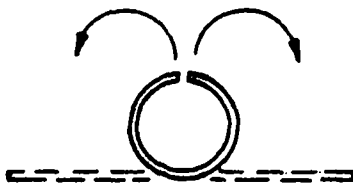


(also a normal piece of G.I.-pipe can do).

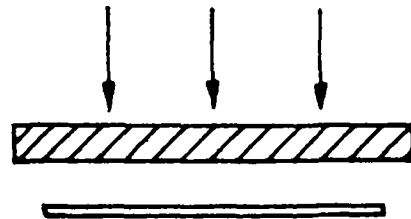
1. prepare a metal welding tool  
outside  $\phi = \text{HDP } \phi + 1 \text{ mm}$  bigger  
inside  $\phi = \text{HDP } \phi - 1 \text{ mm}$  smaller  
than the pipe, for which an end  
cap is required.



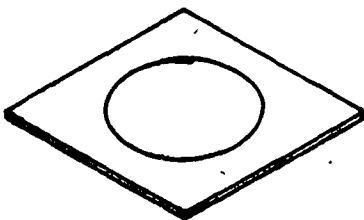
2. Take a piece of HDPE-pipe and  
cut it in the length side.  
(= material for the cap.)



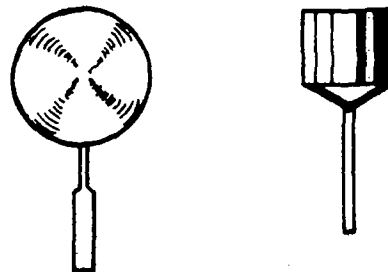
3. Heat the pipe with hot air  
(and not with the flame) and  
open it.



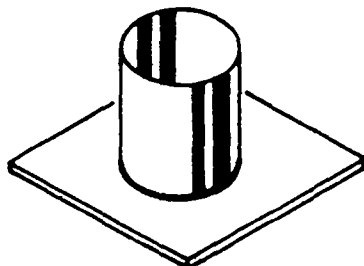
4. Put the HDPE-plate on a flat  
surface and on it a flat wood,  
with some weight on it.  
Wait until it is cold.



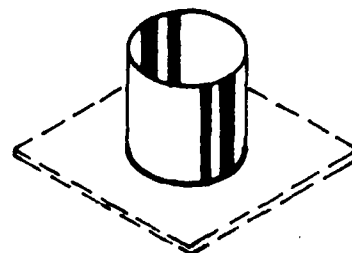
5. Mark the pipe-outsidediameter  
and clean the surface properly,  
necessary for the following  
welding.



6. Heat the welding tools and put  
the plastic-materials on them.  
Welding-plate for HDPE-pipe  
Welding-pipe for HDPE-plate.

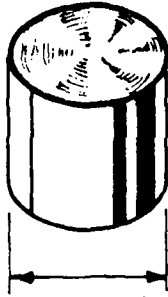


7. Remove the welding tools and  
connect both plastic parts.  
Pressing for appr. 30 seconds  
is essential.

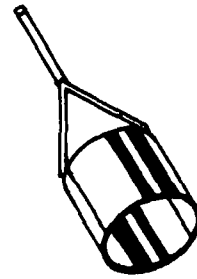


8. The overlapping material can  
be removed, but the welding  
seam should not be cut away.  
(Reinforcement).

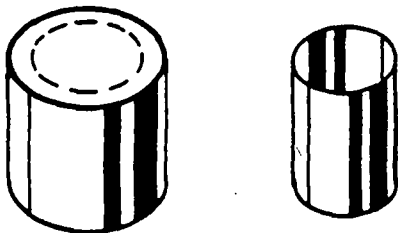
**REDUCER (for low pressure and waste waterlines).**



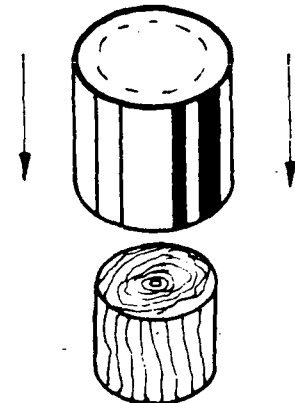
1. Take an endcap (making as before mentined).  
The diameter has to be according to the required bigger one.



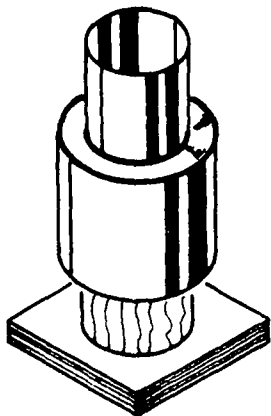
2. Prepare a metal welding tool  
outside  $\varnothing = \text{HDP } \varnothing + 1 \text{ mm}$   
inside  $\varnothing = \text{HDP } \varnothing - 1 \text{ mm}$   
than the pipe, for which the smaller pipe-diameter is required.



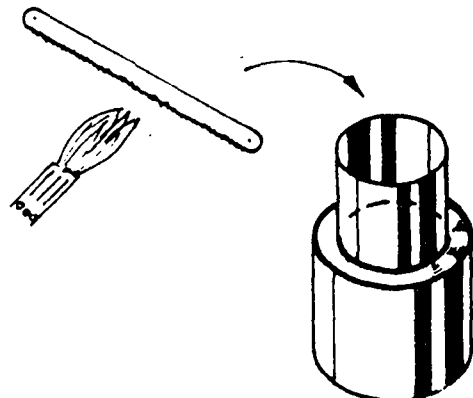
3. Mark the place, where the smaller pipe has to be. Clean the surface on the cover-plate with a knife or glass-paper



4. Prepare a wooden bloc, for the inside of the bigger  $\varnothing$ , as counter-pressure for the welding.

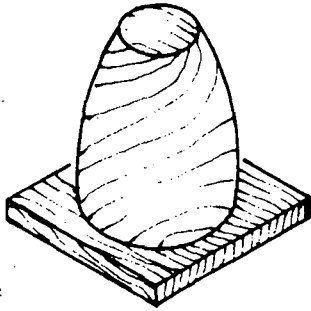


5. Heat both pieces on the welding tools (plate + pipe-tool) an presse them together.

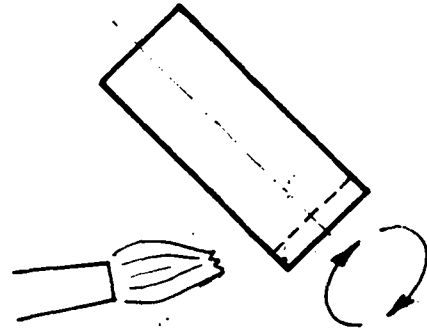


6. Cut out the inside part, but leave the welding-seam existing (reinforcement).

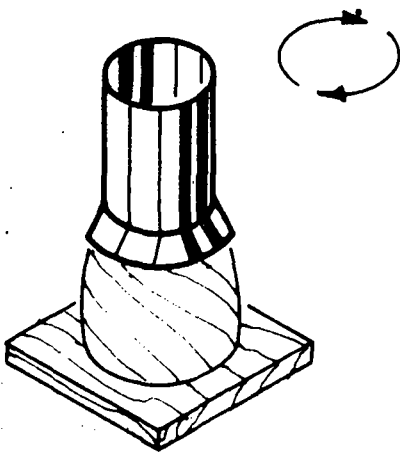
## REDUCER, for small differences in diameters



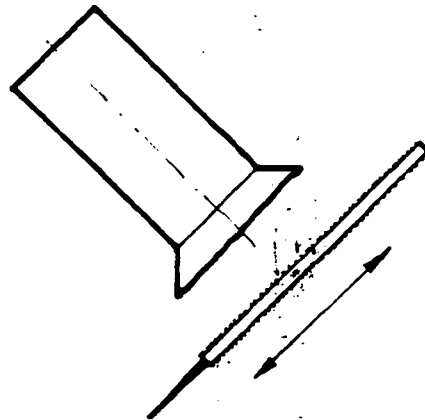
1. Prepare a conical wooden piece.



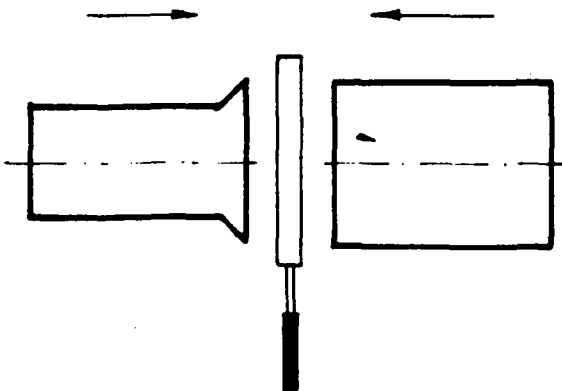
2. Heat the pipe with hot air (on the very end only), until it gets soft, like rubber, prevent over-heating!



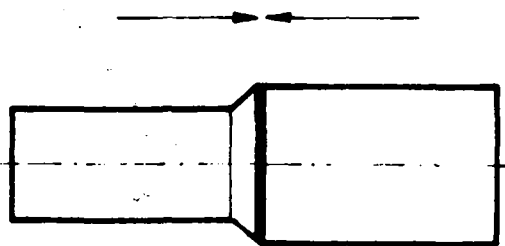
3. Push the piece over the wooden mould while turning.



4. After cooling, make the surface equal and according to the required, bigger diameter.

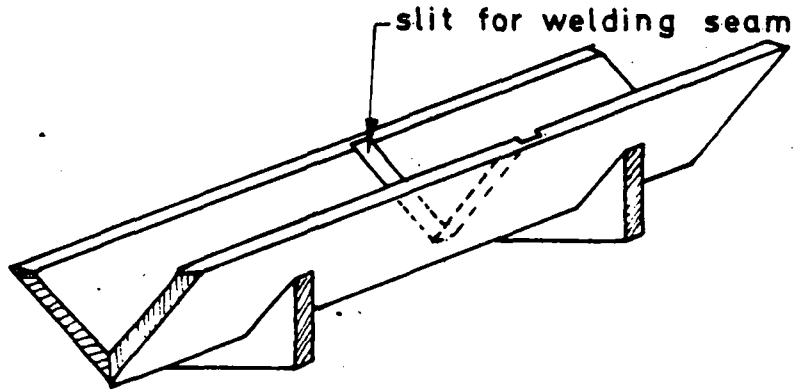


5. Heat both pieces on the welding plate.

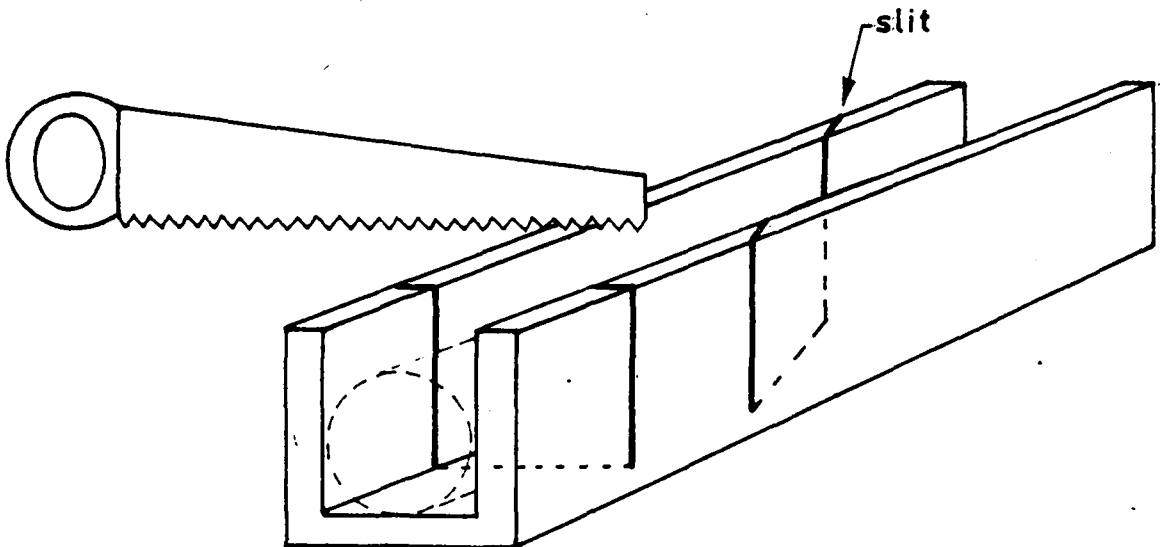


6. Press them together.

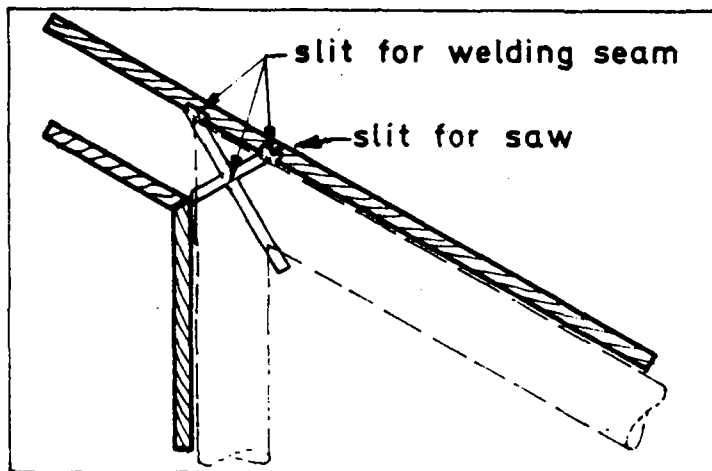
MOULD FOR STRAIGHT PIPE WELDING

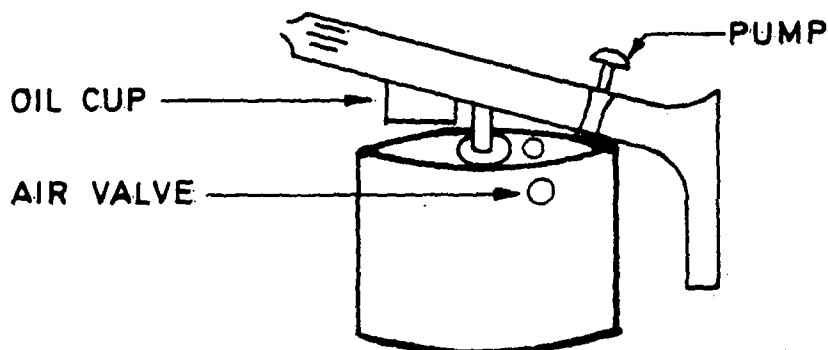


MITER BOX



MOULD FOR BRANCH (WELDING AND CUTTING)





The blow lamp is a portable kerosene torch used by plumbers for securing intense local heat, for melting metals, heating metals and soldering.

#### Operation of Blow Lamp

1. Fill tank  $\frac{3}{4}$  with kerosene. Use a funnel with a filter so that dirt will not flow into the tank and cause a blockage in the outlet.
2. Open Air Valve
3. Fill oil cup with kerosene
4. Light the kerosene in oil cup and leave the match in oil cup.
5. Let the kerosene almost burn out.
6. Close Air Valve.
7. Pump the air pump 15 to 20 times.
8. Lamp should start burning, if it goes out repeat the above operation.
9. To increase flame pump the Air pump again.
10. To reduce flame open the air valve slightly.
11. To stop flame open air valve all the way.
12. If flame smokes or fluctuates, clean the outlet with a cleaning needle.

**IMPORTANT:** If the welding plate is heated with a blow lamp or over a fire, the a teflon-paper has to be fitted over the plate after the heating before the welding can be done! Otherwise the quality of welding will be very bad.