WATER DISPENSING DEVICES AND METHODS FOR PUBLIC WATER SUPPLY IN DEVELOPING COUNTRIES

R262.2 75WA

DRAFT REPORT

PRELIMINARY

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Photograph 1.

Public hydrant
(Ghana - Accra)

1. INTRODUCTION

1.1. PUBLIC HYDRANTS

dynamic process It is only one step along a way

Process includes:
- ind. sources
- grouping devices (fountain)
- water to house
- water in house
- various taps in house

Education is a part that we lower and of this process must bear and is one that the up and does not have

Dispensing of drinking water by means of public hydrants is, in many cases, the only feasible solution to realise a reasonably reliable water supply.
It is very often the cheapest way to put reliable water at the disposal of large groups of the population, both in reasonable quantities and within a short distance of their homes.
However, a number of problems encountered with public hydrants which are fully realised as well are:

- the lack of a responsible consumer (waterbuyer) with whom contractual arrangements can be made, similar to those with private connections;
- the liability to damage when the installation is not supervised by a guard;
- the risk of contamination;
- wastage.

Therefore, it is essential to reflect seriously upon the construction as well as how management, operation and maintenance should be organised.

1.2. OBJECTIVE OF THE STUDY

The objective of the study was to identify ways and means for the dispensing of water at public hydrants which avoid the wastage of water and which can be considered for use on, or adaptation on systems, both urban and rural, in the developing countries.

The study involves two broad areas of investigation:

a. the identification of devices currently in use, previously used or suggested for use by designs, ideas, patents or models and which could be used on urban and rural water systems for the public dispensing of water to people.

in preface

b. the determination of methods and approaches for the control of public hydrants which rely on operational and administration techniques to dispense water to the public.

For the purpose of this study only those public watering points connected to a piped water supply system and intended to make water available for domestic purposes are considered. They are named Public Hydrants. (Depending upon the country they may be called public standpipes, public standposts, public fountains, kiosks, public taps or public spigots)

In view of the limited extent of the study it was not possible to obtain reliable and complete information on all systems e.g. on consumption, wastage, the number of consumers, costs, etc.
However, many examples which were collected are discussed in this report.
It is doubtfull whether a reliable average can be derived from these examples. It is quite possible that some other places have higher or lower values. However, a number of calculations have been made which are partially based on the collected data.

Finally, it has been attempted to provide recommendations on the planning, design and management of public hydrants.

1.3. EXECUTION OF THE STUDY

On request of the Worldbank, this study has been undertaken by the [redacted] W.H.O./International Reference Centre for Community Water Supply (The Hague).

in preface

The main part of the study is executed by International Water Supply Consultants IWACO B.V. (Rotterdam) on request of the W.H.O. International Reference Centre.

Further assistance on the social aspects of the study has been provided by:
- Ir. F. Zandvoort Townplanning Office in Hendrik Ido Ambacht
- The Royal Tropical Institute in Amsterdam.

The study consisted of literature reviews, investigation of project reports, discussion with water supply specialists and collecting of information from manufacturers, institutions and water supply authorities.

Based on these preliminary investigations, visits have been made to several countries where public hydrants exist and are in operation.

1.4. ACKNOWLEDGEMENT

assistance

in preface

During the study much collaboration has been received from the W.H.O.-Head Office in Geneva, the regional W.H.O.-offices, the local representatives of the W.H.O., the Government and Community officials and the Water Supply Companies in all the countries which were visited as well as those who were asked for information in other ways.

2. PUBLIC HYDRANTS IN URBAN AND RURAL AREAS

In Annex 1. a recapitulation has been given of the differences which have generally been noticed with respect to public hydrants in urban and rural areas.

It should be noted that urban areas most often have an organized drinking water supply with financial and administrative management and with operation and maintenance teams.

Although this organization is sometimes very small and often understaffed, it is mostly a lot better than in rural areas where the water supply still has to be organized and where the installations have to be constructed at the same time.

There have been disappointing experiences with public hydrants in quite some rural areas where, shortly after putting into operation of the installations, they had to be closed again either because of complete failure of operation and management or, because the population, wittingly or unwittingly, wrecked them.

Therefore, mostly it is tried now to interest the public of rural areas in the water supply right from the beginning. It is even better to get the initiative from the entire population. It is expected that the population will thus grow to consider the installations as their common property instead of regarding it as something which is forced upon them from the outside.

where?

The autorities hope to achieve in this way that the people will thus take more care of the installations.

In most rural areas, the absence of a water supply organization implies the lack of trained personnel for operation and management.
Primarily of course,it is necessary to use simple constructions. However, the main problem remains the difficulty to train local people for operation and maintenance.
Some training can be given by enlisting as much as possible local labor during the construction period.
In some places in India the local personnel get a special kind of training.
In these cases, facilities have been created for executive technicians of the governmental water supply organization to retire before the time indicated, when the technician is willing to settle in a rural area where a water distribution system is being constructed,in order to supervise the operation and maintenance as well as a trainingprogramme on the job. He will then be in the employment of the local water supply organization. The first experiences seem to be favorable.

3. TECHNICAL ASPECTS

3.1. FAUCET MECHANISM

The systems most frequently in use can be subdivided as follows:

- ordinary taps
- springloaded taps
- self-closing valves
- float mechanisms
- special types.

3.1.1. Ordinary taps (fig.1 A)

Ordinary household tap. In order to get water,the tap is turned open and the water goes on running until the tap is turned close again.

Material:
- brass copper
- cast iron
- other metal alloys
- plastic

Brass copper, however, is often stolen (very popular as melting metal). Many plastic materials are too liable to damage to be used without supervision, however, some experiences with nylon taps are remarkably good.

Advantages:
- simple construction
- the taps are cheap
- there are a lot of suppliers
- simple maintenance
- simple to operate

Disadvantages:
- brass taps are often stolen
- the valve washer (in metal taps) must be replaced regularly
- wastage when the tap is not closed
- the tap as a whole can easily be screwed off the conduit-pipe.

Remarks:

Especially the closing mechanism is a problem because some consumers close the tap too tightly, thus damaging the washer. There have been better experiences with nylon taps where both valve and valve- seat are made of nylon. (fig. 1 B).
One might ask whether it would not be better to have a ball- or plug-valve as the closing pressure is not dependent of the force of closing a tap.
A ball-valve, similar to the one shown in figure 2., might be worth a try.
A plug-valve is used sometimes with a plug of brass-copper. Special disadvantages are: leakage and waterhammer.

Photograph 3.
Springloaded taps (Zambia)

Photograph 2.

Photograph 4.
Springloaded tap in cast-iron supporting construction (Suriname)

Photograph 5.
Gravity operated tap (India-Delhi)

3.1.2. Springloaded or gravity-operated taps

The tap is opened by pushing down a handle or knob or by turning a knob, this always contrary to the spring tension (photograph 2 - 4), or lifting a knob against gravity (photograph 5).
The water goes on running as long as the handle or knob is being kept in this position. As soon as the handle or knob is released the tap closes automatically.
The gravity-operated type which is being used extensively in India, supplies water when the mouth-piece is lifted and stops upon letting it go. The closing mechanism has no spring but works because of gravitaty. (fig. 1 E).

n. pilonne!

Material: - brass copper
- cast-iron
- other metal alloys
- plastic

Advantages: - fairly simple construction
- cheap, only slightly more expensive than the ordinary tap
- closing pressure at the mechanism does not depend on the handling, therefore, little wear of the valve
- simple operation
- not much wastage, if normally operated

Disadvantages: - the handle is often kept opened with rope, wire, stone, etc. which causes wastage
- the tap as a whole is easily screwed off the conduit-pipe
- some systems close badly (leakage)
- waterhammer.

Remarks: There are some systems with cast-iron supporting construction as indicated on photograph 4.

3.1.3. Self-closing valves (fig. 1 C - D)

Similar to the springloaded taps, the tap is opened by pushing or turning a handle or knob.
This tap closes automatically after releasing the handle or knob, but also after a certain time even if the handle or knob is still held in open position.
By re-using the handle or knob the tap is opened again.

Material: - cast-iron
- other metal alloys

Advantages: - closes automatically after use
- cannot be held in open position
- reduction of wastage

Photograph 6.

Siphoide (steel). Water is being sucked through a flexible tube to start the discharge (Gabon, Libreville)

Photograph 8.

Siphoide (concrete, suitable for local manufacture) (Cameroon, Douala)

Photograph 7.

Siphoide type.
Contamination of flexible tube.
(Gabon, Libreville)

<u>Disadvantages</u>: - rather complicated construction with risk of defects
- more specialised personnel is needed for maintenance
- the consumer is challenged to invent something so as to be able to keep the tap in open position continuously.
- the tap is quite expensive
- the tap as a whole can be unscrewed rather easily
- with some systems, the handling requires quite a lot of force.
- waterhammer.

3.1.4. Systems with reservoir and float valve

Here, the reservoir has a direct function for the dispensing of water. The drinking water is stored in a tank. When the tank is filled up, the float-valve closes automatically.

The best-known types are:
- the siphoide
- the bedouin
- the cistern with hand-pump
- the cistern with tap or valve

These systems will be discussed separately below:

3.1.4.1. Siphoide (fig. 3)

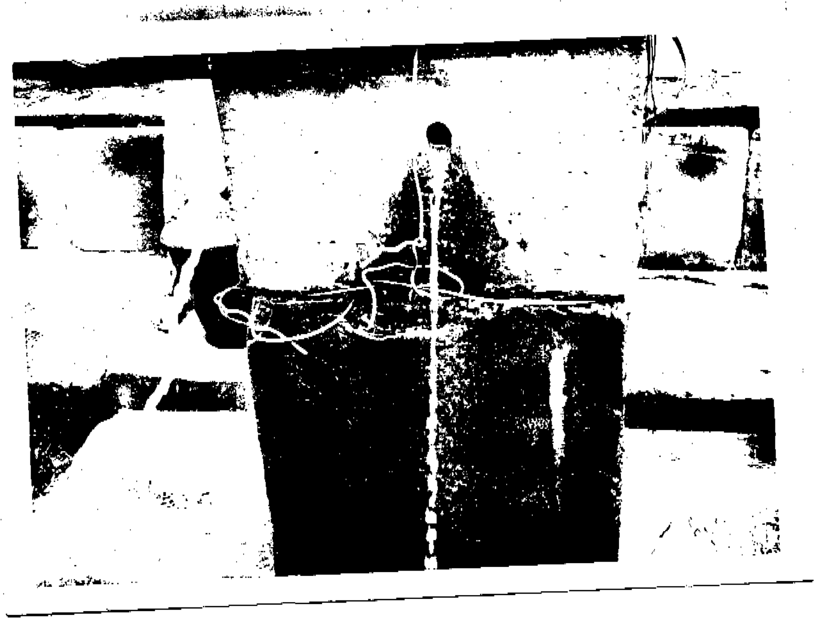
The reservoir of this type normally contains about 200 - 500 l.
With the siphoide system, drinking water can be obtained by putting a flexible tube on the nipple outside the tank. This nipple is connected to the fixed tube on the inside of the tank. Water is then sucked through the flexible tube to start the discharge. (photograph 6)
When the tube is removed, the dispensing of water stops immediately. Generally each consumer has his own flexible tube so he will always remove it when he leaves with the water. This is the basic thinking to reduce wastage in using the siphoide.
The siphoide system has a high risk of contamination as also the private flexible tube itself is very often contaminated. (photograph 7).
The consumers, however, not always only suck on the tube but, especially children, sometimes blow into the tube to produce a "funny noise".

In that way the siphoide system is a clear invitation to revert to the "Broad Street Pump" situation (i.e. The fountain becomes the focal point for infection)

<u>Material</u>: reservoir: - steel
- concrete (photograph 8)

valves and piping: - brass
- cast-iron
- steel
- plastic

<u>Advantages</u>: - If the system functions properly, it reduces wastage
- can be made with local material (except float valve and very often piping)



Photograph 9.

The photograph shows a former bedouin type. The float valve is stuck, the hydrant discharges continuously. (Cameroon)

Photograph 10.

A former bedouin used as a siphoide (Cameroon)

Disadvantages: - capacity per outlet is limited at a low level
- in practice, the closing mechanism(float valve) often functions insufficiently.
- risk of contamination of the water in the reservoir or the tube
- the construction is expensive .

why? give reasons

3.1.4.2.Bedouin (fig. 4).

The reservoir of 100 - 200 l. contains 2 interconnected chambers.
The float valve is in one chamber and a vaned wheel in the other one. The water is obtained from the reservoir by rotating the vaned wheel by means of a handle at the outside.
The water is dispensed only as long as the vaned wheel is rotated. Upon terminating this action, the water discharge stops immediately.

Material: - reservoir: - steel
- concrete
- brickwork

- valves and piping: - brass
- cast-iron
- steel
- plastic

Advantages: - if working properly, the wastage is small
- can be easily manufactured with local materials (except valves and piping)

Disadvantages: - if the vaned wheel is cheaply finished, it is subject to a lot of wear (bearings)
- the capacity is too reduced
- in reality the float-valve often functions insufficiently, thus leading to damage when efforts are made to raise the discharge capacity
- risk of contamination of the water in the reservoir
- expensive in comparison with a tap.

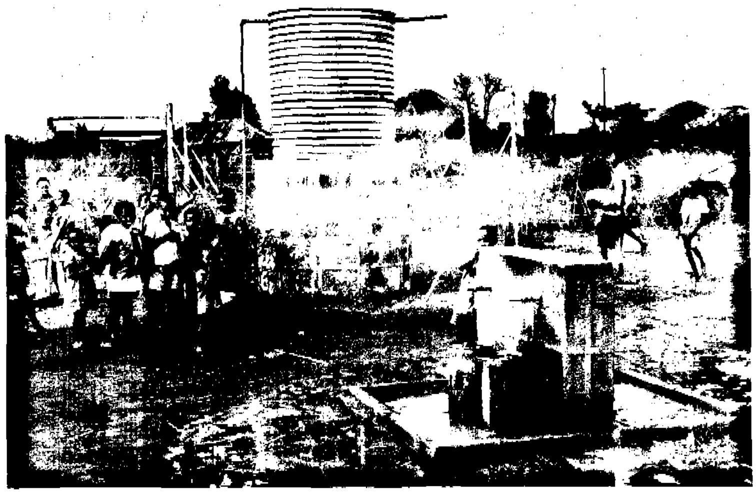
why? give reasons; one type more than others; do we need other float valve or other approach?

Remarks:

The bedouin system has been formerly used in Cameroon. After some time these devices did not function as they should. All bedouin types missed the handle for rotating the vaned wheel.(photograph 9).It appeared that children liked to play with the rotating wheel until the shaft and wheel were completely eroded.
The only remaining possibility to use the hydrant was to ~~re~~ remove the vaned wheel. The hole, now obtained, can then be used to insert a tube; thus the bedouin type was transfered into a kind of siphoide type (see photograph 10)

Photograph 11.

Overground reservoir with taps at the side
(India, Virar)



Photograph 12.

Small reservoir near public hydrant
(Kenya)

3.1.4.3. Cisterns (fig. 5, 6 and 7)

Reservoirs with a contents of 1 m^3 or more are generally used in regions where sufficient pressure on the main distribution net is not permanently present.
They are refilled during the hours when there is sufficient pressure.
Generally the closing mechanism is operated with a float valve. Sometimes there is only a hand-operated valve, or in some cases there is no valve at all.
In fact the function of these reservoirs is that of a service reservoir in a distribution system but only in relation to the public hydrant concerned.
The overground reservoirs have one or more taps which supply water (see fig. 5 and 6, photograph 11 and 12)
Water from an underground reservoir is often withdrawn with a handpump. (see fig. 7)

Material: - reservoir: - brickwork
- concrete
- steel

- valves and piping: - brass
- cast iron
- steel
- plastic

Advantages:
- economising of the capacity of the treatment plant and the pumping station and of the diameter of transport and distribution mains, by using the over-capacity during the hours of low consumption
- possibility of discontinuous production and continuous water supply
- can be fabricated with local materials mainly
- when using an underground reservoir and handpump there is hardly any wastage.

Disadvantages:
- all systems with cisterns have high investment costs for reservoir
- there is risk of contamination of the water in the reservoir
- specially for underground reservoirs an effort is necessary to draw water, which might cause too much reduction of the consumption
- handpumps need frequent inspection and maintenance.

Photograph 13.

Tap discharges as long as the handle is rotated. (Type Bayard) (France, Ardèche)

Photograph 14.

System with normal valve. The elevated part is made of reinforced plastic. (fabricated in large quantities) (Mexico)

3.1.5. Special types.

There are a number of public hydrants constructed of a cast-iron standpost with the piping and valves at the inside. The construction is integrated with the outlet. Some of the tap mechanism are springloaded or gravity operated (fig.8.)
The french type Bayard only gives water as long as the handle is being rotated. The tap closes when the action is stopped (photograph 13).

Material: cast-iron.

Advantages:
- firm construction of support
- most types have a special closing device to reduce wastage.

Disadvantages:
- expensive
- rather complicated construction
- difficult maintenance
- many parts which wear easily

There are also types similar to the above which are constructed in plastic instead of cast-iron (photograph 14). The piping is constructed at the inside but the closing-mechanism is a normal tap.

Material:
- elevated part: reinforced plastic
- base unit: concrete
- valve and piping:
  - plastic
  - steel
  - brass copper

Advantages:
- solid construction for tap and piping
- cheaper than cast-iron construction
- the form is easily recognisable

Disadvantages: - same objections as for normal taps.

Another special construction is the foot-operated tap. See fig. 9).
It is a springloaded tap which is operated by foot instead of by hand.

Material: - supporting construction: concrete

- valve and piping: - plastic
  - steel
  - brass copper

Advantages: - simple to operate
- little wastage when normally used

Disadvantages: - when a heavy stone is put on the foot-pedal (which is very temping) the water goes on running.

Remarks:

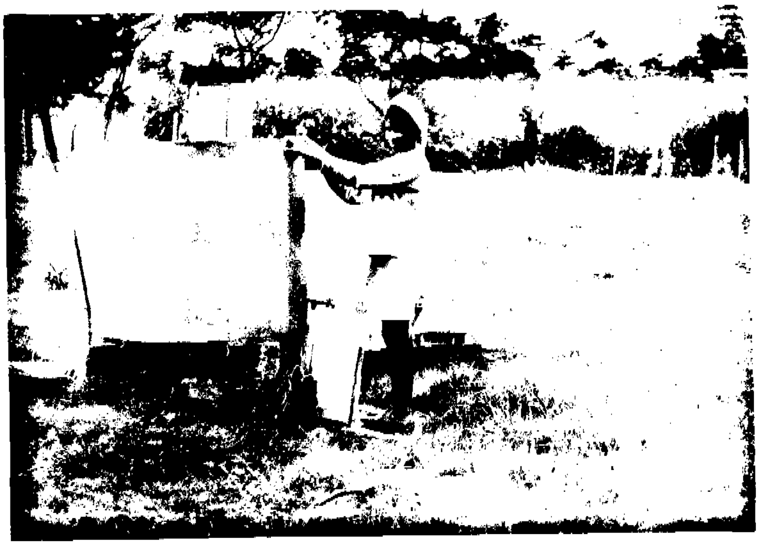
When using foot-operated public hydrants, it would be advisable to have a tap of the self-closing type.

3.2. PIPING AND METERING.

In principle the connection between the distributionmains and the public hydrant is technically similar to that of the private connection. (fig.10 and 11).
The diameter of the connectionpipe generally is somewhat larger than the one of a normal houseconnection depending on the number of taps connected to the public hydrant.
A service pipe of ½" to 1" is usual for 1 - 4 taps.

Material: - galvanised steel
- plastic to be installed only underground preferably to avoid damage.

The main valve should be installed underground or in a space which can be locked.
Type and diameter will be chosen in accordance with the construction of private connections in the same region.
The use of a watermeter may give important information for studies on the consumption and wastage, for calculations of future consumption and on decisions about additional public hydrants or the closing of some of them.
Sometimes a watermeter is necessary for recovery of the cost of water supplied.
Preferably, meters should only be used when they are necessary and when there is a proper and regular maintenance in a workshop specially staffed and equiped for this type of work. The meters should be read regularly and the results should be administrated carefully.
If the above conditions are not fulfilled it is better not to have a meter. In these cases it is preferable to reserve the possibility to build in a meter in case it would be required later on.



Photograph 18.

Tap directly connected to the reservoir (Zambia)

Photograph 19.

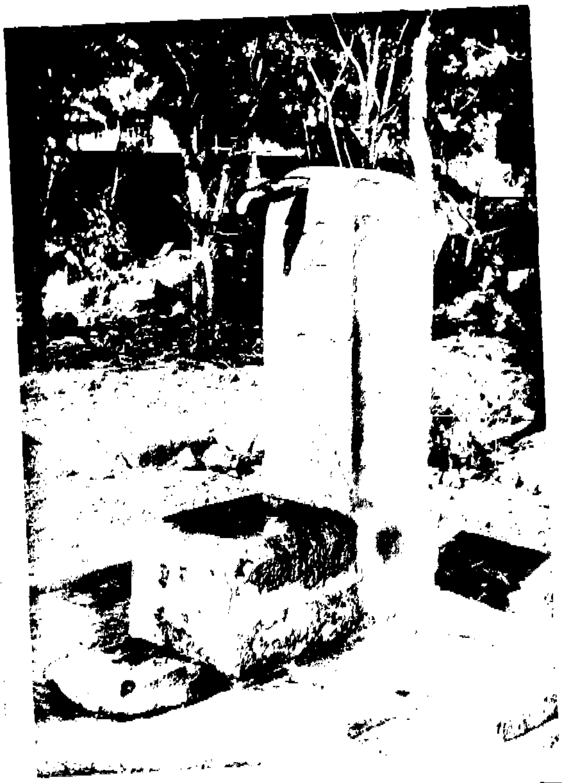
Simple platform dewatering into the street (India, Delhi)

Photograph 15.

Unsupported hydrant with two taps.
(Zambia)

Photograph 16.

Support is higher than top of tap.
(Ghana)



Photograph 17.

Tap and piping supported by concrete pipe.
(the top of the tap is higher than support)
(Mauritius)

3.3. CIVIL WORKS.

3.3.1. Construction of support for the piping and taps.

The most simple construction is an unsupported pipe on which the tap (or 2 taps if necessary) haves been fitted (see fig.10 a, b ; photograph 15).
The construction is only acceptable in courtyards for a restricted number of people. or for very temporary installations. Even then it is preferable to fix the supply pipe to a post or wall.(see fig. 11.a,b.).
A solid construction of a public hydrant is essential. Sometimes the conduit is strengthened (e.g. by using 1" steel pipe or even more).
It is much better, however, to encase the pipes in masonry or to attach the pipe and tap to a pile or a wall (see fig.12-16, photograph 17).
It is advised to make the construction of support at least 0.1 m higher than the top of the tap to have a point of support on which to put full casks before putting them on the head to take along (fig. 12-16, photograph 16).
With systems directly connected to a reservoir, which are sufficiently strong themselves only the foundations are important.(photograph 18).
This will be looked into more closely lateron.
It should be mentioned that systems with their own (cast-iron) support only need a foundation for stability.
In general, attention is drawn at a good and stable construction of support and foundation. In many cases an inadequate construction causes breakage in the connecting pipes thus causing much breakage.

3.3.2. Platform for debbies.

Below and around a public watering point a strong platform, which is easily kept clean, should be present (fig.12-16).
Depending on the local situation, a simple pavement of local materials or tiles, or concrete is advised.
There should be a proper dewatering from the hardened surface to a central point (photograph 19).This is necessary from a hygienic point of view and in cold regions also because of ice formation round the tap.

Photograph 20.

Platform under the taps
to put on buckets (Haïti)

Photograph 21.

Hoses connected to the taps
because it is impossible to
fill the drums under the tap.
(Upper Volta, Ouagadougou)

At the central point a hole with drain should be made. It is advisable to elevate the sides of the platform to at least 0.10 m above the surrounding terrain level. Underneath the taps small platforms or grids should be made to put on the casks used for drawing water(fig.17., photograph 20).The heights of the small platforms should be adapted to the local customs.
In case debbies are being carried on the head, the height should be 0.4 to 0.5 m for children and 0.9 to 1.0 m for adults.

In places where casks are rolled or transported on wheels, a raised platform under the taps would not be appreciated. Then a hose will be attached to the tap to facilitate filling (photograph 21 Ouagadougou) (risk of contamination).
The height of the tap over the small platform depends on:
- casks for normal household use must fit in between
- whether bathing of children under the tap is permitted

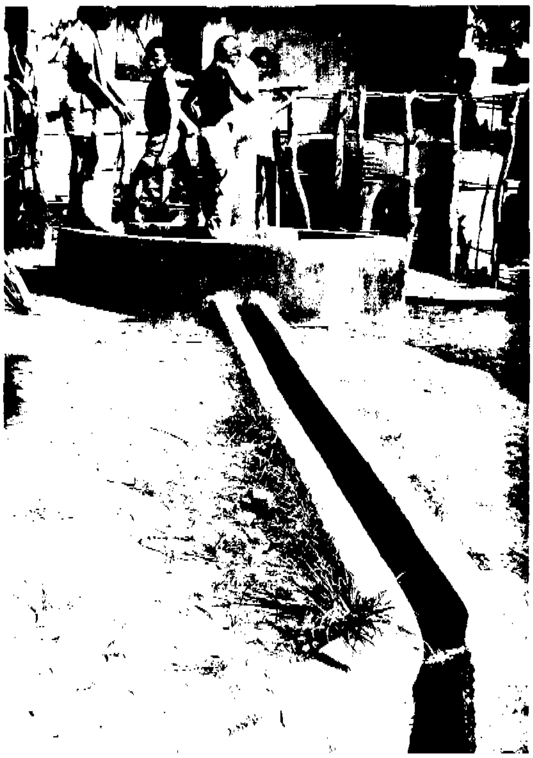
If sufficient water is available to permit bathing under the tap, a height of about 1 m is advised. But when water is too scarce, the minimum height for casks, generally about 0.5 m should be kept.

Some places rather have the buckets put on a grate (see fig. 18). Then the waste-water goes right down and may be easily discharged through a small outlet in the platform. From a hygienic point of view, this solution is preferable to a concrete platform. The disadvantage is that the grate may corrode and collapse.
Therefore, a cast-iron grate should be preferred.However, such a grate has to be specially constructed.

In many countries extremely simple platforms of brickwork or concrete are made underneath each tap and the height may vary. Several usual heights have been indicated in figure 19.

Photograph 22.

No discharge of waste water.
(Congo, Brazzaville)



Photograph 23.

Effective waste water discharge in storm drainage system.
(Congo, Brazzaville)

3.3.3. Collection and discharge of waste water.

In order to keep the platform clean it is necessary to have an effective collection and discharge for leakage and rinse water as well as for rainwater. Otherwise large mud pools may develop.(photograph 22).

When the rising pipe holds only one or two taps, with or without a supporting pillar, but without a platform, it is advisable to have a soakage pit of e.g. 0.50 x 0.50 x 0.80 m3 filled with rubble or gravel through which the leakage water can drain into the soil (see fig. 10 and 11). This construction is anything but ideal and in fact only acceptable when:

- the tap is used by a limited number of people (e.g. courtyard hydrant)
- the soil is very pervious so that drainage is indeed effective.

When using a platform, sloping towards the outside an effective result may sometimes be obtained by putting a sufficient quantity of rubble or gravel in front of the low side of the platform (see fig. 10-13).
Here also, the drainage system has a limited capacity and should only be used when:

- the number of consumers is not too large(e.g. less than 100).
- the soil is pervious.

A more effective solution, however, would be to lead all water streaming down into a central place and thence discharge the water by means of a waste pipe or gutter (see fig. 14,15,16).

If possible the overspill should be drained off and put to some other use such as:

- drinking trough for cattle
- irrigation of gardens in the near surrounding of the tap
- in an irrigationcanal.

When use of the overspill is not possible or not desired by the population,direct discharge to the existing sewer system or stormdrainage canals is advised (photograph 23).

Photograph 24.

Waterkiosk
(Kenya, Nairobi)

If no re-use and discharge through the existing systems is possible, it is advisable to infiltrate the waste water into the ground by means of soakage trenches or seepage pits (fig.20,21).
These constructions are not suitable in heavy clay soil; necessary is a certain permeability for a normal result.
The length of soakage trenches can be adjusted if the permeability is low.
If the working of the seepage pit is insufficient the most suitable solution is to make a second one.
An insufficient functioning of a soakage trench can be improved by lengthening, or by making a second one at a distance of more than 10 m apart from the first.
In both cases the conduit has to be conducted to the new extension.
Well elaborated examples of soakge trenches and seepage pits are given in Rural Sanitation in the Tropics of The Ross Institute.

3.3.4. A protective wall is necessary if the tap has to be protected against traffic (if adjoining the road) or against cattle.
A raised border of 0.2 m around the platform should give enough protection against collision.
A higher wall of about 0.8 m would be advisable in case of expected damage by cattle.
When there is a lot of damage done by cattle it would be advisable to have metal grids at the entrance as well (see fig.16).

3.3.5. Kiosk system.

If the public hydrant is being guarded by a watchman, who generally also sells the water, in some countries a cabin which can be locked, is built for the guard.(photograph 24).
Usually this kiosk is built in such a way that the guard can control the taps from the inside.
Only the mouthpiece of the taps shows on the outside of the wall (an example is given in fig.22.)
For the connection of taps, platforms for debbies, discharge of waste water etc. the same recommendations can be given as those afore mentioned.

Photograph 25.

Waterkiosk in a confort
station (Kenya, Nairobi)

3.3.6. Comfort stations.

If a public hydrant is constructed near or in a building where public toilets, showers and washingrooms are united (built together) this offers a number of technical advantages. The same inlet may be used for other purposes as well. The waste water discharge may be conducted to the sewage system or the sink hole (well) of the comfort station.
The public taps are preferably put against or next to the outerwall of the comfort station and not on the inside. Both the consumers and the water supply experts prefer the first way because of hygienic reasons.
When there is a kiosk-system, it would be a good idea to include a room for the guard. (photograph 25)
As far as the construction of tap and platform are concerned, there is no difference between a detached public tap or a public tap, as part of a confort station.

3.4. CAPACITIES.

The output of a tap is determined by the construction and dimension of the faucet and by the pressure in the main conduit-pipe.
The suppliers of the various types of taps mostly have graphs available to show the output at different pressures. Some examples have been given in fig.23.

Supposing the pressure in the distributionnet is about 15 to 20 mwc, and putting the loss of pressure in the connection main at 5 mwc, then the pressure at the tap is 10 to 15 mwc.
This results into an outlet capacity of a normal household tap of : Ø 1/2 of 13-17 l/min. (about 900 l/h)
Ø 3/4 of 25-30 l/min. (about 1500 l/h).
Compared to the above, the Fordilla has a capacity of 10-12 l/min. (about 600 l/h). A ball valve and a plug-tap have, with the above mentioned pressures, much higher capacities depending more on the diameter of the pipe than on the tap.

Some examples of calculations of the required number of taps are given in Table I on the next page.
These simple calculations may, if so required, be extended with a larger or smaller number of consumers, with a different division of the consumption per 24 hours and with other types of taps.
It is clear that the siphoide has a limited capacity. Generally 3 or 4 outlets on a siphoide are usual. Therefore, the maximum real capacity is between 500 to 1000 l/h, which almost equals one normal household tap.
Consequently, the siphoide should only be used for a small number of consumers.
In general, public hydrants have 1, 2, 3 or 4 taps. Only rarely do systems have more taps.
Experience shows practically always that a large number of taps (more than 3 or 4) results in more vandalism and wastage.
The required number of watering points corresponds with the output per tap, the number of consumers and the consumption per head.
The contents of a bucket or debbie, generally used to fetch water, varies between 5 and 20 l, although the latter is fairly common in a lot of places.
The number of consumers per public hydrant varies between about 200 and several thousands.
When there is a large number of consumers, it is always very dubious in how far they all depend on the public hydrants.
Authorities generally keep a target number of 200 to 500 people per public hydrant. Water consumption of public watering points varies (in practice) between 5 and 50 l/cap. per day.(lcd)
Design criteria vary between about 15 to over 100 lcd, and in regions where cattle also drink from this water one should add a bit.
Quite often design criteria, up to about 100 lcd are used, when designing treatment plants, pumping stations, transport and distribution systems, in the cases that a gradual change from public hydrants to private connections is expected.

TABLE I

Examples of calculations of capacity to determine the number and diameter of taps or outlets per public hydrant.

Number of people served by one hydrant	Consumption in lcd	per public hydrant l/d	per public hydrant l/h	Theoretical discharge per tap l/h	Efficiency factor	Real effective use per tap l/h	Required number of taps or outlets	Remarks
200	20	4.000	1.000 1)	900 2)	90% 4)	810	2	normal tap
200	20	4.000	1.000 1)	1.500 3)	90% 4)	1.350	1	normal tap
200	20	4.000	500 5)	900	90%	810	1	normal tap
200	20	4.000	1.000 1)	600 6)	80% 7)	480	2	selfclosing tap
200	20	4.000	1.000	300 8)	70% 9)	210	5	siphoide
200	20	4.000	500 5)	300	70%	210	3	siphoide
200	40	8.000	2.000 1)	900 2)	90% 4)	810	3	normal tap
200	40	8.000	2.000	1.500 3)	90%	1.350	2	normal tap
200	40	8.000	1.000 5)	900 2)	90%	810	2	normal tap
200	40	8.000	1.000	1.500 3)	90%	1.350	1	normal tap
200	40	8.000	2.000 1)	600 6)	80% 7)	480	5	selfclosing tap
200	40	8.000	2.000	300 8)	70% 9)	210	9	siphoide
200	40	8.000	1.000 5)	300	70%	210	5	siphoide
500	20	10.000	2.500 1)	900 2)	90% 4)	810	3	normal tap
500	20	10.000	2.500	1.500 3)	90%	1.350	2	normal tap
500	20	10.000	1.250 5)	900 2)	90%	810	2	normal tap
500	20	10.000	1.250	1.500 3)	90%	1.350	1	normal tap
500	20	10.000	2.500 1)	600 6)	80% 7)	480	5	selfclosing tap
500	20	10.000	2.500	300 8)	70% 9)	210	12	siphoide
500	20	10.000	1.250 5)	300	70%	210	6	siphoide

AMPLIFICATION OF TABLE I

1) Consumption is supposed to take place mainly during 1 to $1\frac{1}{2}$ hours in the morning and during another 1 to $1\frac{1}{2}$ hours in the evening. Thus, the peak load per hour would be about 1/4 of the total daily consumption.

2) Capacity of 1/2" household tap is estimated at 900 l/h.

3) Capacity of 3/4" household tap is estimated at 1500 l/h.

4) Consumers take each others place very quickly during the peak hour; the tap goes on discharging almost continuously; the output is almost 100% (a working maximum for this efficiency factor has been put at 90%).

5) Supposing the consumption would be spread out over a larger part of the day than mentioned under 1), thus the peak load per hour would be 1/8 of the daily consumption.

6) Capacity of a tap of the self-closing type has been put at 600 l/h.

7) Because of repeated pushing of the knob the real discharge capacity of this selfclosing type is supposed to be only 80% of its rated capacity.

8) 300 l/h is the estimated capacity of 1 nipple of a siphoide or of the outlet of a bedouin type.

9) Because of the need to change tubes, the efficiency factor of one nipple of a siphoide is estimated at 70% of its rated capacity.

Most variables in the table are based on estimates. The capacity of the siphoide per outlet is based on a (rough) hydraulic calculation.

4. FINANCIAL ASPECTS.

4.1. INVESTMENTS.

In table II the amounts have been given which are, according to data obtained in some countries concerned, necessary to construct a new public watering point of the type in use in that country.
Comparatively there is a lot of uncertainty about these figures as the amounts have generally been estimated as a part of a larger contract for the supply and/or construction.
Moreover, it is often difficult to assess which are additional costs such as: connection to the distribution system, ground purchase, soil preparation, costs of design, import duties and taxes.
Therefore it is impossible to distill from these figures an exact insight into the differences of investments between one type or another.

TABLE II. INVESTMENT COSTS FOR STANDPIPES (US $)

	VALVE OR TAP ONLY	INCLUDING BASE UNIT *)
1. Ordinary taps	1 - 3	
- without support and platform		50 - 100
- with simple platform		200 - 500
2. Springloaded taps		
- taps with platform	5	300 - 1000
- Neptune	200	500
3. Selfclosing valves		
- Tylor	approx. 15	500 - 700
- Fordilla	approx. 15	500 - 700 **
- Tropicale	250	600
4. Float mechanisms		
- Siphoide	700	1000 - 2000
5. Special types		
- Bayard	300	600

*) Cost estimates based on situation existing in some countries

**) If Fordilla valve is used as a public standpipe

In Annex 2. estimates of the various devices have been made, based on unit prices which have been more or less taken as an average for the developing countries.
Large fluctuations to either side may arise especially caused by import duties, taxes, transport costs, wages, labour efficiency, etc.
However, from these estimates it is possible to get an indication of the differences in costs of investments needed for some types of hydrants.
No effort has been made to distinguish between local currency and foreign exchange components in these estimates, since large differences would be found between one country and another.

It should be borne in mind, however, that in many developing countries ~~the availability~~ ~~of~~ foreign exchange is available in very limited amounts. Besides it needs to be stressed that because it is dealing with such a poor sector the public hydrant concept is very susceptable to the use of any devices (taps, etc) that require the use of hard currency or foreign exchange.

4.2. COSTS OF OPERATION AND MAINTENANCE.

It is almost impossible to find out the separate costs of either operation or maintenance
Generally these activities are done by personnel who are also in charge of other activities, such as maintenance of the distributionsystem, construction and reparation (maintenance) of the private connections.
In cases where each public hydrant has its own guard, the guard is practically always in charge of simple maintenance. Only for difficult repair work a fitter, mason or contractor is sent for from time to time.
Upon enquiries of a number of officials of the Water Supply Organisations or committees who are responsible for operation and management, it appears that each public hydrant should be inspected once a week.

For a hydrant of a construction as given in fig. 15 - 21 or similar, maintenance might be done in a reasonable extend with one surveyor or a fitter, who will be able to do small repairs in the same time and to check and inspect about 25 (in rural areas) to 50 (in urban areas) public hydrants a week.
Besides, for each 250 public hydrants, 1 fitter, 1 mason and two labourers would be necessary for larger reparations.
For supervision will be needed one supervisor for 500 hydrants.

The above mentioned desired personnel is an arbitrary estimate and it would be advisable to have a special investigation done into this.
A cost estimate for operation and maintenance, based on the above, has been given in table III.
It goes without saying that the activities are influenced by the quality and the type of construction.
But the behaviour of the population is of much more importance. The necessary input may differ either way caused by either careful or wanton and destructive behaviour of the consumer.

The estimates have been meant as a first effort to qualify and quantify the costs of operation and maintenance of the public hydrants in the hope that it may be a stimulation to get better figures.

TABLE III

Cost estimate of Inspection and Maintenance (urban areas)

All costs in US $

Personnel and Material	Yearly cost including overhead	Number of hydrants served *)	Costs per hydrant
supervisor	2,000	500	4
daily inspection and small repairs:			
- fitter	1,000		
- tools	100		
- transportation	100		
- materials	500 +		
	1,700	50	34
larger repairs:			
- fitter	1,200		
- mason	1,000		
- 2 labourors	1,400		
- tools	400		
- transportation (small truck)	4,000		
- materials	3,000 +		
	11,000	250	44
			82
Miscellaneous			18
Total yearly costs per hydrant			100 US $

*) In places with less hydrants than may be maintained by one person or a team, the remaining time may be spent on other work.

4.3. COSTS OF WASTAGE.

Apart from damage which may be caused by water running off, part of the costs also consist of the value of the wasted water. There are in the first place the operation-costs of treatment and transport(pumping). Waste water, however, takes also a pro rata part of the capacity of intake, transport, distribution network and reservoirs. Thus the value of the waste water comes very close to the average costs of water supplied by means of house-connections.
Quite often there is a large disparity between cost and price of the water. The price of the water may be either higher or lower than the costs.
trivial
If the Water Supply Organizations make a profit, the prices are higher than the costs.
This may be the case both with private or (semi-) governmental companies.
The latter may use the profit to finance other, in their opinion important governmental projects (tasks).

In developing countries, however, the prices according to the tariffs, are more often below the real costs.
This is possible only if part of the costs are paid from outside means e.g. the Government or external aid-funds financing the investments.
In the following paragraph an effort has been made to show the influence of the costs of wastage compared to other costs.

4.4. EFFECT OF THE MAIN ELEMENTS ON THE COSTS OF WATER AT THE PUBLIC HYDRANT.

in dit verband niet opvoeren; geen onderdeel kostenraming

As described in the paragraphs 4.1., 4.2. and 4.3. the main elements on the cost of water at a public hydrant are investment, the costs of operation and maintenance and the costs of wastage of water.
An effort has been made to give an insight into the relations between these cost-elements.
The costs per cubic meter water, supplied to the public hydrant by the Water Supply Organization can be considered as constant, for they are independent of the type of public hydrant.
The wastage of water at the public hydrant must also be paid, so the cost price of the consumed water will be higher when more water is wasted.
This relation can be described with a simple formula:

$$C_{c1} = \frac{1}{1-W} C_b$$

with:

C_{c1} = Costs of the water actually consumed in US $\$/m^3$, only taking into account the general production costs and the wastage of water

C_b = Overall costs of the water, supplied by the Water Supply Organization in US $\$/m^3$

W = Wastage factor ($0 < W < 1$), as part of the quantity of water transported to the public hydrant.

$W = 0$ means no wastage

$W = 1$ means 100% wastage

Upper left in figure 24 this relation is shown graphically for different costs of the water supplied.

A second group of costs consists of the annual costs of depreciation, maintenance, operation costs and if applicable costs of a guard at the public hydrant. This can be expressed in the following formula:

$$C_{c_2} = \frac{(a+b)I_p+E_o+E_g}{q_c}$$

with:

wat is verschil tussen maintenance en operation by public hydrant

- C_{c_2} = total of second group costs per m3 of water actually consumed in US $/m3
- a = factor for interest and depreciation
- b = factor for maintenance and replacement

zelfde kosten

- I_p = capital investment per hydrant in US $
- E_o = annual costs of operation
- E_g = annual costs of a guard in US $ (if applicable)
- q_c = annual consumption per hydrant in m^3

The lower right hand corner in figure 24 gives this relation between the annual costs per hydrant and these costs per m^3 of consumed water for different annual consumption rates.

The total costs per m3 of consumed water (C_c) are thus the sum of the above mentioned cost components C_{c_1} and C_{c_2}.

This means in formula:

$$C_c = C_{c_1} + C_{c_2} = \frac{1}{1-W} C_b + \frac{(a+b)I_p+E_o+E_g}{q_c}$$

In figure 24 the contribution of these elements to the cost of consumed water can be seen.
The handling of this figure, which is only meant to give an insight into the problem, will be explained in the following examples.
First of all some elements must be estimated. The wastage for instance is not only dependent on the quality of the hydrant, but much more on the mentality of the people, the number of consumers per tap, the possible presence of a guard, etc. In this example three cases will be discussed.

At first we will assume that the wastage factor will be 0.5; in the second case the wastage factor will be reduced to 0.2 due to the presence of a guard; in the third case it is supposed that the presence of the guard will have no influence on the reduction of the wastage which will be 0.5 as in the first case.
With no guard present quite often water consumption is not paid for; this has also been assumed in this example.

If the presence of a guard means payment for the water then this will also influence the amount of consumed water. In the first case it is supposed that 600 consumers will consume from one hydrant 4000 m^3/year (approximately 20 lpcd)
It is assumed that the amount of consumed water when it has to be paid for, will be 25% lower (e.g. 3000 m^3/year) than when there is no payment.
The capital investment for the standpipe is supposed to be US \$ 1,000.--; it is assumed that the annual costs for interest, depreciation and maintenance will amount to 20% of the capital investment.
The costs of operation and revenue collecting (E_0) are supposed to be US \$ 100.- per year, and the annual costs of a guard US \$ 500.--
The overall costs of the water supplied to the public hydrant are supposed to be US \$ 0.3/m^3.
Based on these assumptions the three examples will be discussed hereunder.

Waarom zo hoog?
Zie tabel blz. 20
(beter getal US \$ 250.-)

Voor civiele gedeelte (incl. aanvoering) ander perc. dan voor mechanisch.

EXAMPLE I.

- No guard ($E_g = 0$)
- Wastage 50 %; $W = 0.5$
- Annual consumption $q_c = 4000\ m^3/yr$
- Operating costs E_o = US \$ 100.--/yr
- General production costs C_b = US \$ 0.3/m^3
- Capital investment of public hydrant I_p = US \$ 1000.--
- Factor for interest and maintenance $a + b = 0.2$.

From the wastage factor and the general production costs it can be seen in figure 24(A→B→C) that the costs of consumed water with regard to purchase and wastage will be C_{c_1} = US \$ 0.6/m^3.
The annual costs of the public hydrant will be:

$$(a+b)I_p+E_o+E_g = 0,2 \times 1000 + 100 + 0 = \text{US \$ } 300.\text{--}$$

With an annual consumption of 4000 m^3/year the costs of the hydrant are C_{c_2} ≡ US \$ 0.075/m^3 (D→E→F)
The total costs of the consumed water can be found by adding C_{c_1} and C_{c_2} : C_c = US \$ 0.68/m3 (C→I and F→I)

EXAMPLE II.

Guard present (E_g = US \$ 500/yr)with reduction of wastage.
Wastage 20%; $W = 0.2$
Annual consumption $q_c = 3000\ m^3/yr$
Operation costs E_o = US \$ 100/yr
General production costs C_b = US \$ 0.3/m^3
Capital investment of hydrant I_p = US \$ 1000.--
$a + b = 0.2$.
The annual costs of the hydrant are now US \$ 800.-- with a guard present.
Analogous to example I the costs of consumed water(II) can be found by adding C_{c_1} (K→L→M) and C_{c_2} (P→Q→R).

fout, na berekening $0.642

In the figure can be seen that ~~the~~ total costs of the consumed water are ~~US \$ 0.6/m^3~~, US \$ 0.08/m^3 less than in the previous example.

EXAMPLE III.

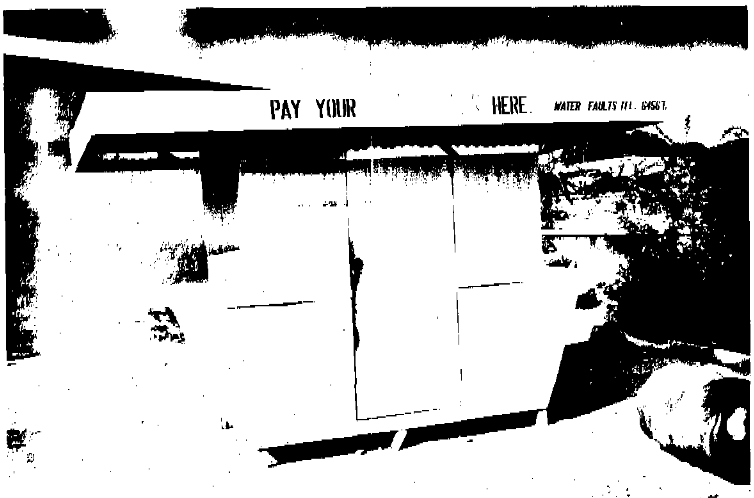
Guard present (E_g = US \$ 500/yr) with no reduction of wastage
Wastage 50%; $W = 0.5$
Annual consumption $q_c = 3000\ m^3/yr$

Operation costs E_o = US \$ 100/yr
General production costs C_b = US \$ 0.3/m^3
Capital investment of hydrant I_p = US \$ 1000.--

The annual costs of the hydrant are again US \$ 800.--.
C_{c1} can be found along A-B-C in figure 24 and C_{c2} along P→Q→R.
The total costs per m^3 consumed water (C_c) can be found by adding these figures (C→III and R→III) at US \$ 0.87/m^3.

These three examples mainly show the influence of the wastage on the costs of the consumed water.
The influence of the total annual consumption at a public hydrant can be seen in a fourth example.
Suppose the hydrant, as described in example II, is replaced by three similar types, also with a guard, and the wastage factor remains at 0.2.
The annual consumption per hydrant will then be 1000 m^3/yr instead of 3000 m^3/yr. The value of C_{c1} will be the same as in example II(US \$ 0.37/m^3, point M in figure 3).
The costs per standpipe per m^3 consumed water (C_{c2}) will now be US \$ 0.8/m^3 (P→S→T).
The total costs will amount to C_{c1} + C_{c2} (M→IV and T→IV) US \$ 1.17/m^3 of consumed water, as represented by point IV in fig.24.

Conclusie eraan verbinden?
(Aanbeveling)



Photograph 26.

Centre for collecting waterrates,
fixed at a levy per house.
(Ghana, Accra)

Photograph 27.

Watercarrier (vendor) paying
the licenceholder.
(Upper Volta, Ouagadougou)

In the fringe areas of cities what needs to be done
of the delivery system (be it a fountain or a tap) one which will have the following characteristics:
1) can identify a buyer (be it a water vendor or an individual customer)
2) the delivery cost is the lowest feasible
3) payment system is adapted to users life style (people often have 10¢ a day, but not $3. in a month)

The problem in smaller communities is often of a different nature because there is no "company" to deal with.

In lieu of ... Chapter 4?

4.5. REVENUE COLLECTION.

The revenue collection from consumers depending on public hydrants is a generally recognized problem. There are many reasons underlying this problem. In many countries an emotional resentment exists throughout the population against paying for water that must be carried home. Furthermore, poor administration, such as irregular revenue collection and poor service such as bad water quality, low pressure and discontinuous supply have an adverse effect on the willingness to pay. Finally it appears that often the Water Supply Organizations lack power to enforce payment, as it is undesirable or virtually impossible to close public hydrants in case of non-payment.

Consequently, politicians, governmental or water supply officials in many countries are in favour of a free water supply at the public hydrants.

In case it is decided to recover the cost of water, there are several ways that may be used:

- charge per house (or plot) per month (both in urban and rural areas);
- levies on crop or cattle (in rural areas);
- contribution to a committee (in rural and squatter areas)
- payment at the tap to a guard or licenseholder.

An example of the first way can be found in some places where the consumer from public hydrants has to pay at kiosks, installed at various places in the town or area. (Photograph 26). Obviously it is very difficult to check whether all consumers of the different hydrants in the area actually pay their contribution.

In several places an efficient revenue-collection is organised by payment at the tap to the hands of a guard or licenseholder (Photograph 27).

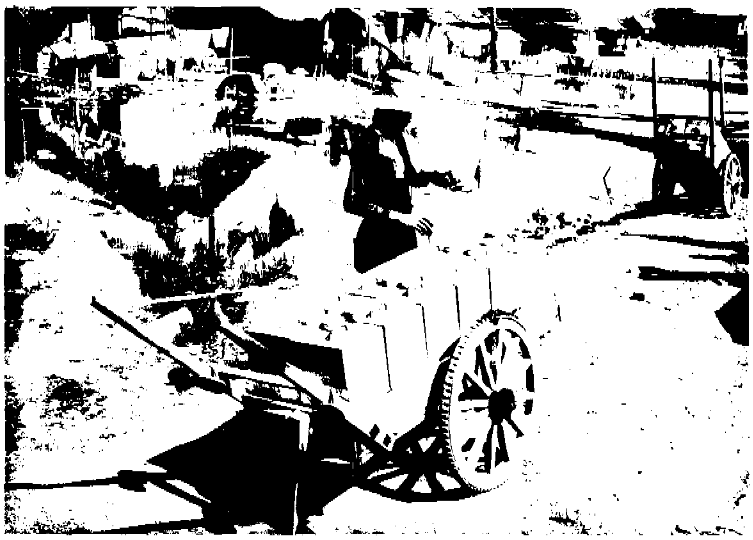
However, this system too does not always work satisfactorily. The main problems are:

- the guard misuses his position of authority, refuses to serve some, demands prices which are too high, puts too little pressure on the tap or opens the taps only at inconvenient hours.
- the guard is afraid to lose popularity thus badly exercising his function.
- the guard is unable to maintain authority and/or discipline and cannot collect the money (revenues).
- the guard damages the installation by careless maintenance and operation.
- sometimes there are troubles between the guard and the water supply organization such as: disappearance with the revenues, a strained relation between supervision and guard.

It depends on the mentality and the political situation in a country whether a system with a guard or licenseholder will work or not.

Photograph 30.

A watercarrier with yoke
(Upper Volta, Ouagadougou)



Photograph 31.

Watercarrier
(Indonesia, Jakarta)

Photograph 28.
Watercarrier (Mexico)

Photograph 29.
Watercarrier filling his drum.
(Upper Volta, Ouagadougou)

An important phenomenon is the watercarrier or vendor. (Photographs 28 through 31).
Watercarriers obtain their water at the public hydrants and sell it at the houses, serving people who do not like (or are unable) to get water themselves but like to be served privately.
Watercarriers have been encountered in quarters of some cities supplied by public standpipes, as well as in the new quarters, where no water supply system exists at all. Depending on the distance between the hydrant and the consumer some tariffs for delivery by watercarriers are given in the following table IV.

TABLE IV. SOME EXAMPLES OF WATER RATES WHEN WATER IS DELIVERED BY WATERCARRIERS.

	Costs in US \$ /m^3	
	delivered by water supply company	delivered by watercarrier
Upper Volta	0,3	1 - 1,5
Ghana	0,1 *	1,25 - 2,5
Senegal	free	1,6 - 2,4
Indonesia (Jakarta)	0,07	appox. 6
Uganda (Kampala)	0,33	1,3 - 3

*) estimated costs based on monthly use and levy, per house; in practice the water is free for the vendor.

It is noticable that consumers sometimes pay exorbitant prices for the water delivered by water-sellers.
One may wonder why the people do not fetch water at the public hydrant themselves in those cases. However, sometimes the distances are so long that it fully explains the raise in price of the water-sellers.
It also happens that the public is not given the opportunity by the guard or licenceholder to obtain water from the public taps and are thus fully dependent on the water-seller.

wellicht ook hier scheiding in rural urban

4.6. TARIFFS.

There are 3 distinctly different groups of tariffs of water at public hydrants:

1) free of charge (tariff zero)
2) a levy per family, per house, per plot, on crop and on cattle etc.
3) payment at the tap per unit quantity of water.

If the water supply at the public taps gives no direct revenues as in case 1), the costs must obviously be paid from other sources; such as e.g.

- included in the charge on the water consumed from private connections
- funds from the municipality, province, government etc.
- from local or foreign aid funds.

A number of alternative policies concerning the level of water-tariffs or levies can be considered:

- revenues should cover the costs
- tariffs based on ability to pay
- based on willingness to pay
- tariffs increasing gradually in the time as the consumers enjoy the benefits.

If there is a tax-levy per family, house or plot the amounts generally vary between 0,25 and 2,0 US $ per month per family. The amount depends on the financial strength of the population.
The maximum revenues, collected this way, generally cover not more than the costs of operation and maintenance.
Sometimes capital-costs are partly covered in this way.
Only when there is a supervisor or revenue-collector, by order of the municipality of the Water Supply Organization, or when someone acts as licenseholder or retailer, payment is made at the tap.
The official tariffs of some countries are given in table V.

TABLE V.

EXAMPLES OF RATE OF CONSUMPTION AND WATER TARIFFS AT PUBLIC HYDRANTS

COUNTRY (city)	Monthly supply per public hydrant (m^3)		quotient maximum/minimum	Average number of persons for one p.h.	Average supply lcd	watertariff US $/m^3$ **)
	average	max./min.				
UPPER VOLTA						
Ouagadougou	375	500/220	2.27	1850	6.5	0.3
Bobo Dioulasso	247	300/150	2.00	1550	5	0.3
GABON						
Libreville	711	1754/235	7.46	3300 ?	7	0.5
Port Gentil	236	283/200	1.41	750	10	0.5
Lambarene	71	120/ 39	3.07	1200	2	0.5
CAMEROON						
Douala	393	484/291	1.65	1450	8.5	0.2
Yaoundé	487	?	?	2250	7	0.26
INDONESIA						
Cirebon	60	?	?	1000	2	?
Jakarta	?	?	?	?	3	0.07
INDIA						
Delhi	270	?	?	500	18	?
Jalgaon	650			125	180 *)	?
KENYA						
Nairobi	180	?	?	?	?	0.13

*) Intermittant supply in a distribution system with public hydrants without taps (open pipes!)

**) This is the price charged by the Water Supply Organization for water supplied to the public hydrants. Consumer prices may be higher because of resale.

5. EXPLOITATION AND MANAGEMENT.

5.1. OWNERSHIP.

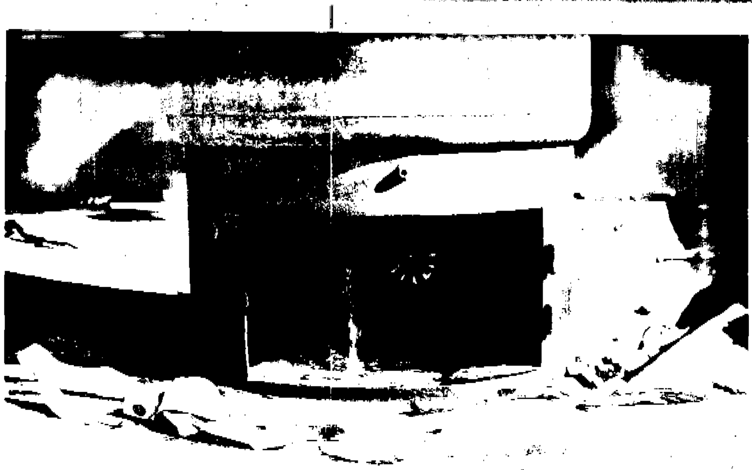
The public hydrant is generally owned either by:

- A Water Supply Organization
  - national
  - regional
  - municipal
  - private
- the Municipality (without Water Supply Organization)
- A committee or association
- Sometimes even, a public hydrant is privately owned(e.g. by a mission-station or some other help organization).

Out of the above mentioned owners, only the Water Supply Organization generally has a staff of trained personnel to take care of maintenance and administration of the public hydrant.
It often happens that public hydrants are constructed, with or without help of the Water Supply Organization, on request of a municipality or one of the other above mentioned groups.
Because the problems of exploitation and payment are always difficult, the Water Supply Organization is very willing to leave this in the hands of the group who took the initiative for the construction.
In this way there are many cases where the daily management of the public hydrants is not done by the Water Supply Organization but by one of the other above mentioned groups.
The Water Supply Organization considers, so to speak, the public hydrant as a private connection of this group, who make the public hydrant available as a public installation. Quite often the managing group has to pay the Water Supply Organization for the consumed water.

Photograph 35.

Lever to lighten the heavy operation of the Fordilla tap. (Suriname)



Photograph 36.

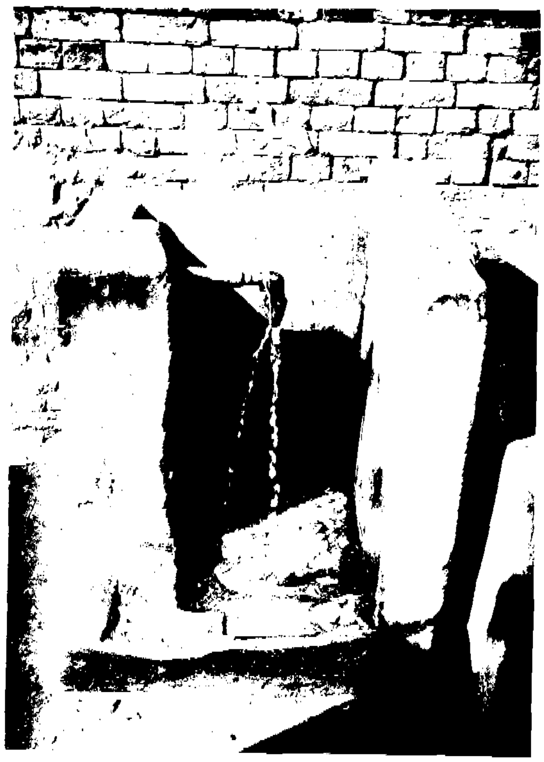
Siphoide type.
The float valve is stuck, thus continuous discharge by overflow.
(Gabon)

Photograph 32.

Leakage caused by wear
of the valve-washer.
(Upper Volta, Ouagadougou)

Photograph 33.

The pipe supplying the public hydrant is sawed off at a low level to get more water if the pressure is low (India, Bombay).



Photograph 34.

A gravity operated tap is wired up, thus continuously discharging.
(India, Delhi)

+ KIT 5 (non-operational publ. st)

5.2. WEAR - DAMAGE - THEFT

The number of complaints on deficiencies of public hydrants is almost endless. Because of intensive use, excessive wear and the possibility of damage are present. Moreover, the consumers generally do not consider the public hydrant as their property and therefore, hardly any care is taken.
For these reasons it is to be advised to have the constructions as simple and at the same time as strong as possible.
Generally the tap is the most vulnerable part of the public hydrant. The difficulty with the simple tap is that the valve-washer wears out quickly which causes leakage.(photograph 32).
The springloaded tap could be an important improvement, but the construction is allready a lot more complicated, and the consumers generally try to find ways and means such as ropes, stones etc. to keep the hydrant discharging continuously, which often leads to damage of the tap.
Quite often damage or wrecking is started off because the consumers try to "improve" the hydrant either to get more water by cutting the pipe (photograph 33) or by binding up the automatic interruption of the discharge (photograph 34)or to ease a too heavy handling (photograph 35).
It seems,that the more sophisticated the tap in avoiding wastage, the more inventive the public gets to find an easy way to obtain water.
Therefore, it is rather doubtful whether the selfclosing taps would be advisable for public hydrants.

A group of hydrants also challenging to the public, are the installations which only give water as long as the action is continued by the consumer (bedouin, reservoir + handpump, and system Bayard).
The basic thought of the designer,that the discharge stop upon terminating the action,is all right.
But when there is a reservoir, it is often "invented" that if the floatvalve is put out of action, this facilitates the drawing of water a lot.
Moreover, the movable parts of these constructions are fragile, and liable to wear and damage.
Another specially developped system is the siphoide where the water supply stops upon removal of the hose.
It is not clear whether the many damaged floatvalves (photograph 36) of this installation have also been purposely damaged to enable the drawing of water without a hose.

Damage on purpose does occur, sometimes out of pure mischief, but more often resulting from too low a pressure on the tap. Sometimes, as a result, the tap is taken apart.
It also happens that the rising pipe is sawed off or bent down in order to get more water (photograph 33). Therefore, distribution systems having sufficient pressure and continuous supply are to be preferred a lot to those with much difference in pressure and discontinuous supply.

Especially when the material is valuable, theft occurs. In many places brass (copper) taps are frequently stolen to remelt them into objects for daily use or embellishment.
As said before, these intensively used public installations will always show deficiencies after more or less time. Therefore, regular supervision and maintenance are essential.

5.3. INSPECTION

In many cases, only when complaints are laid with the responsible organization, does inspection take place.
In urban areas regular inspection is sometimes done by the municipality or sometimes by the Water Supply Organization, depending amongst others, on who pays for the water.

- If the Municipality pays for each m3 of water supplied, they will generally check more or less regularly whether there are large leakages such as broken circuits, broken taps and such.
- If the water is supplied free of charge by the Water Supply Organization, the latter is more inclined to inspect.
- If there are guards, licenceholders or watchmen at the tap, they normally take care of the daily supervision as well.

In rural areas, supervision is often done by a local committee.
Sometimes personnel is employed to supervise and to do the necessary reparations (or turning off) at the same time.
Here as well, supervision is often insufficient or even almost completely non-existent.

5.4. MAINTENANCE

Regular maintenance is necessary on taps and other moving parts (such as the vaned wheel of the bedouin or the hand-pump of the underground cistern). It is also sometimes necessary to do some repairs on the platform, the construction of support and the attachment of piping to the picket or the wall.
If a watermeter is present, it has to be read and checked.
All the above mentioned activities have to be carried out by a fitter.
It would be advisable to clean the platform and the drainage system regularly. This can be done by unskilled labour.
Hovever, there are few places where the above mentioned simple care of the public hydrants is undertaken regularly.
In urban areas or areas under supervision of a Water Supply Organization, it makes a lot of difference when someone of the lower or middle management level is interested in the maintenance of the installations.
Unfortunately, in these areas the public hydrants are generally considered as undesirable and to be replaced by private connections at the earliest possible.

Much better care is taken in (some) towns where the public water dispensing is done by guards, licenceholders or kioskholders. But even then, there is no guarantee at all for proper maintenance.
By involving the population in the care if this public property, many rural areas try to encourage care and maintenance.

It should be noted that the feeling for, and acceptance of regular maintenance is most often less developed in the countries under consideration.
Apart from the question of mentality, it is essential to remove material and other restrictions for maintenance by seeing to it that:

- finances are available
- know-how is available
- man power is available
- management and administration functions properly.

Where these commodities are most scarce, the more complicated systems seem worst.
On the other hand, the system that may prove the most suitable depends on the mentality of the consumers which in turn may be influenced by education, information and eventually by involvement.

5.5. WASTAGE

Some preliminary remarks should be made here on the definition of wastage at public hydrants. Many investigators and designers have put much weight on waste reduction. This resulted in the construction of special valves types, rationing of water, appointment of guards, etc.
The question of what should be considered as usefull or necessary waterconsumption goes far beyond the scope of this study. For the purpose of this report it is proposed that all water drawn from a public hydrant, intentionally serving a specific goal, should be considered as <u>use</u> of water. Consequently, all other water discharged from the tap is called <u>wastage</u>.
This implies that for example, rinsing of vessels or bathing of children at a public hydrant is to be considered as <u>use</u> of water. The question whether this kind of water use should be promoted or reduced is not to be decided upon here, Unnecessary or undesirable use of water which is normally considered as misuse or wastage in discussions on public water supply systems is very difficult to limit by technical or administrative means only, without creating undesirable side effects.

The basic approach in this study has been that a public hydrant should not limit or hamper the "use" of water as defined above.
The overspill of water at a public hydrant, thus is composed of water wastage and water used at the public hydrant.
The quantity to be drained from the area of a public hydrant finally is the overspill plus any other (rain) water entering the area.
The reduction of wastage at public hydrants has been sought by the following basic means:

a. by using taps that only discharge if so desired, or by installing taps with limited capacity.
b. by installing systems which give water only and as long as some effort is made.
c. by rationing the water supply to the public hydrant during specific hours of the day.
d. by appointing licenceholders who sell the water at the public hydrants.
e. by educating and involving the consumers so that they will take good care of the installations and use the water in a proper way.

Sometimes these measures may also lead to an undesirable reduction of the use of water at the public hydrant.
It should be stressed here again that in all cases sufficient inspection and maintenance is of prime importance.
Nevertheless, the large wastage at many public hydrants is remarkable. Wastage may be caused by wrongly operated hydrants, by wear of taps and valves, by broken, damaged or stolen taps and (float)valves as well as sawed off conduits, and by leaking conduits.

The most frequently occuring form of wrong operation of the hydrant is leaving the tap opened after use, or in case of a spring-loaded tap, fixing it in open position and leaving it that way. Many designs have been made to prevent this. The various constructions have been discussed in chapter 3.
The wastage resulting from the above is different in each case. During the field investigations, the number of taps found left open after use was relatively small. Especially in rural areas and small communities a certain discipline is often present to prevent this type of wastage.

Normal wear of taps (washers!) and valves causes a continuous leakage (photograph 32).
Wear is reduced to a minimum when there are as few fragile parts as possible, which have been constructed as solidly as possible.
A nylon tap, a plug valve or a ball valve may be preferable to a tap with a washer.

Most systems which close automatically suffer from wear of the moving parts. Types with a reservoir often have worn float-valves, resulting in permanent overflows. The vaned wheel of the bedouin type very often shows signs of wear.
In practice, many public hydrants are found to be in poor condition even shortly after their installation. However, it should be quite well possible to minimize wastage resulting from wear for most types of taps by simple but adequate maintenance.

Purposely wrecked installations may result in valves that are broken, damaged or stolen. As already discussed before, three reasons are important:

- because the material is valuable
- because water is then more easily obtainable
- because of sheer mischief.

In those cases the wastage will be substantial as most types of public hydrants go on giving water once the closing device is gone.Some types with a reservoir have the advantage that they stop supplying water completely. However, it is almost certain that the pipe will then be sawed off to get the water directly from the distribution net. Then wastage is at its maximum.

A normal problem for each Water Supply Organization is the leakage of the service pipes or private connections. In the total water supply system this leakage can amount to considerable quantities.
As a wastage factor, leakage of the service pipes of the public hydrants is generally less important than the others.

All difficulties mentioned above can be minimized by proper and regular inspection and maintenance.
There could be a positive influence when the public is taught that it is important for everyone to use the public hydrant well.
There are a lot of indications that the fact whether the public hydrants are more or less sophisticated constructions does not primarily lead to limitation of wastage.

Photograph 37.

Catching of rainwater in wet season.
(Gabon)

Photograph 38.

Some public hydrants serve too
many people (Haïti)

6. SOCIAL ASPECTS

6.1. APPRECIATION

In places where water can be obtained also from the river, from shallow wells and pools or as rainwater from the roofs, the population not always prefers the public hydrants as a matter of course.
Apart from larger distance or possible payment, personal and cultural preferences are very important.
People are creatures of habit, they have their own criteria for appraising the alternative water sources and for judging the quality of the water (taste, colour, odour).
Quite often the water at the public hydrants is not used by everyone in a quarter, sometimes it is only used for certain purposes and sometimes also only in certain (dry) seasons. (photograph 37).
This explains the extremely low consumption figures sometimes found (often much less than 10 lcd), for the public hydrants.
Once they are accustomed to draw water from the public hydrants, almost all consumers would like more hydrants.
In some cases it is obvious that the public hydrants serve too many people (photograph 38).

6.2. COMPLAINTS CONCERNING CONSTRUCTION

by: Constructions

Only a comparatively small number of complaints are specially directed against specific constructions.
This is logical since the population mostly knows no alternatives.
Complaints generally concern: too much effort is needed, e.g. too much springpressure of the operating system, continuous effort such as constantly having to keep the tap opened; too small a discharge from the tap e.g. because too low a pressure.
The population may try to solve these difficulties themselves which often results in misuse or damage of the public hydrant.

6.3. PAYMENT

by: revenue collection

Payment for water at the public hydrant is a rather general problem. It is an almost universal thought of the consumers that water which must be fetched should be free. Therefore, the willingness to pay is fairly non-existent. Moreover, it is extremely difficult to make out a contract for a reasonable system of payment for water supply at the public hydrant unless a guard or licenceholder at the tap is employed.

6.4. POLITICAL PROBLEMS

Large illegal quarters of some cities cause special socio-political problems.
If the Government is unwilling to recognise these quarters, no infra-structural work is done. Although, good drinking water, which would stimulate hygienics, would be very important especially in those quarters, it quite often happens that piped water supply is not provided on purpose. Consequently, this results in a flourishing black-market for drinking water.
However, necessity will prevail over planning and politics in due time.

6.5. INVOLVEMENT

verwerken
in aantal en
verminderen

A tendency which has been noticed in a lot of places, in order to solve some of the many problems in relation to the public hydrants, is to involve the population more into the construction, operation and maintenance as well as into the administration of the distribution systems by means of public hydrants.
It is to be hoped that the above approach will be successful as the problems in relation to the public hydrants which seem to be technical and financial problems, are in fact human (and therefore social) problems.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. EXPERIENCES AND CONCLUSIONS

Among the most important experiences and conclusions obtained from the investigations are those listed below:

a. The ideal tap or water dispensing system for public hydrants does not exist. From everyday practice the impression exists that the more complicated systems do not show a definite advantage as far as waste reduction is concerned in comparison to an ordinary tap. The most effective means to reduce wastage (however, often also consumption) to a minimum appears to be the licence-holder who sells the water at the public hydrant.
The most desirable system, taking into account all aspects, should be a hand-operated tap of good durability in combination with effective maintenance and proper use and operation by the consumer. The latter objective may be attained by education, information and involvement of the public.
Systems with mechanical devices to reduce the discharge and/or wastage often have been found to be a challenge to the consumers to find ways to "modify" the system in order to make water more easily available.

b. In many places conditions have been found that raise serious doubts as to the hygienic reliability of the water carried home. Among these are:
   - systems to which flexible tubes have to be attached (siphoide) or may be attached (most ordinary taps and several types of special taps).
   - systems using underground reservoirs that can easily be contaminated.
   - the sale of water by a guard or licenceholder. In this case containers are often not rinsed before filling for reasons of economy.
   - those systems that stimulate resale, such as systems with long waiting times and systems with long walking distances.
   - those systems in which the immediate surroundings of the tap(s)are not kept adequately dry and clean because of poor platform lay-out and/or poor drainage system. Especially inadequate drainage is more the rule than exception.

c. Proper inspection and maintenance is the basic requirement for every system in order to operate satisfactorily.

d. Direct recovery of the cost of water from the consumer causes problems for two main reasons. Firstly, because it is generally felt as an injustice to have to pay for water that must be carried to the house. Secondly, the lack of a responsible consumer with whom contractual arrangements can be made.

e. Especially in urban areas where water is supplied by a more or less independant organization, this organization often is not paid for water supplied to the public hydrants. In these cases the Water Supply Organization is likely to try to reduce the number of public hydrants, whereas the Municipality may have the opposite interest.

f. In case water from public hydrants is re-sold by water-carriers, consumers often pay a higher monthly sum for water than those having a private connection.

g. A clear distinction can be made as to the involvement of the consumer, between rural and urban areas. In rural areas it is easier to involve the public in installation, management and operation of the water supply system, resulting in a more carefull use of the same. On the other hand, many difficulties are found in rural areas to realise effective maintenance and repairs.

h. Relatively few examples have been encountered of combinations of public hydrant with other public facilities, such as washing places or comfort stations.

c. Management, operation and maintenance

- a decision should be made to provide water free of charge or to recover the cost in part or completely from the consumers.
- a clear definition of those organizations, or persons responsible for management, operation and maintenance, and their specific tasks.
- ways and means to provide manpower and finances required for operation and maintenance.
- provision of workshops, spare parts and tools required for proper maintenance and repairs.
- a decision should be made to provide a guard for each public hydrant, or not.

It is clearly impossible to provide clear cut figures and solutions for the above mentioned criteria, since social, economic, political and other factors vary widely from place to place.
However, it seems justified to provide already some indications of the limits within which figures may lay and the directions in which decisions may be sought.
They are summarized below:

- Daily and maximum hourly consumption per capita from public hydrants is usually overestimated. Our experiences have shown very low values. Daily consumption figures per capita may be found between 10 and 50 lcd and 20 lcd could be considered as an average.
- The number of people depending on one public hydrant should not exceed 500 (normal) or 1000 (extreme).
- The maximum walking distance should not exceed 200 m (normal) or 500 m (extreme).
- The best type of tap to be used is subject to many pertinent factors and subjective ideas. An ordinary tap may give as much satisfaction as the most complicated device.
  It should be borne in mind that a tap is as good as the maintenance and repair it receives.
  One of the most important factors might be the fact whether waste reduction is of prime importance or not.
- The tap or outlet should be constructed in such a way that it is impossible to connect a hose, since the latter is frequently contaminated.
- The discharge per tap should be between 200 and 2000 l/h, taking into account the system and the feed pressure.

- The number of taps per public hydrant should in our opinion not exceed 4 (normal) or 8 (excessive). When the aforementioned criteria are established the number of taps follows directly from the following equation:

$$\text{number of taps} = \frac{\text{number of consumers} * \text{max. hourly consumption/capita}}{\text{discharge per tap} * \text{efficiency factor}}$$

  The efficiency factor may be put between 0.7 and 0.9 depending on the type of tap (chapter 3).
  If the number of taps thus found, exceeds 4 (8), either the number of public hydrants or the discharge per tap should be increased. The latter possibility is of course limited by one of the criteria mentioned before.
- For the supporting and surrounding constructions the report gives examples of acceptable constructions. The potential user might study these in order to find the best solution for his conditions. Among the points to be considered when making a selection from the various possibilities are:
  - the way the water is transported by the consumers (e.g. on the head, by hand)
  - the type of bucket, debbie, etc. normally used locally
  - the fact that children and grown-ups may use the public hydrants

  If possible, the public hydrant should be installed on a place which is higher than its immediate surroundings in case of inadequate drainage.
- Drainage or overspill and other water in many places is a serious problem.
  If a(storm) drainage system is present this may also serve this purpose. If not, one of the next solutions may be selected:
  a. if the soil is sufficiently permeable, seepage pits or trenches should be provided.
  b. in case this proves not to be possible, every effort should be made to bring waste waters outside the immediate surroundings of the public hydrant (e.g. on an adjoining slope).
- In cities management, operation and maintenance could most often best be provided by the Water Supply Organization. Paricipation by the population is mostly limited to selfhelp programmes during the construction period. In the field of operation and maintenance, participation is difficult to obtain.
  On the contrary in rural areas it is necessary to let the community take as large an interest in the public water supply system as possible. Some form should be found to provide sufficient financial resources and specialized know-how for planning, design and "difficult"maintenance.

ANNEX 1.

SUMMARY OF SOME SPECIFIC CHARACTERISTICS OF THE USE OF PUBLIC HYDRANTS IN URBAN AND RURAL AREAS.

	URBAN	RURAL
Starting point:	- existing water supply organization	- no existing water supply organization
Initiatives	- municipality	- cooperation of Government, Ministries etc. - setting up of - committee - organization - interesting the population in water supply - on request of local groups
Planning and design	- by an existing organization with or without outside help (Ministries, especially public works and water departments, World Organizations, consultants, Mostly done by technical organizations.	- outside help only (Ministries, especially Ministry of Health, Social Affairs, World Organizations, volunteer organizations, consultants). - mostly done by Health Organizations
Investments	- mostly Water Supply Organization or Municipality, Governm. - grants or (soft) loans	- (partly) coming directly from the population (labour, and/or contribution in money) - mostly outside help
Construction:	- Water Supply Organization, Municipality of contractor, - sometimes by partly enlisting the population (labour)	- outside help through Ministry, contractor or volunteer organization and by enlisting local labour
Administration and operation:	- Water Supply Organization with more or less skilled personnel	- local committee (with outside help) unskilled (local) personnel (problems of training)
Maintenance	- Water Supply Organization	- Committee with non- or partly trained personnel, with assistance of regional or national organization
Water-quality:	- generally conform to the W.H.O. International Standards	- sometimes meeting the W.H.O. International Standards, but often untreated surface water with large deviations of quality
Payment:	- mostly free - through guard, licence holder or kioskholder - fixed amount per house or per plot - by general system of taxation	- provision of operation and maintenance costs: - contribution to committee - fixed amount per house - a charge on important crops or cattle - sometimes free of charge
General:	- mostly everything is managed, operated and maintained by the existing Water Supply Organization	- the population is more involved in the accomplishment and maintenance of the system - much less expert knowledge is available

A N N E X 2.

1. Rising pipe + 1 tap. (fig. 10A)

	Unit	Quantity	Cost incl.labour	
			per unit	total
-Connection on the main + service valve		1	15.-	15.-
-Service pipe (Ø 1/2")	m	20	2.-	40.-
-Stop cock, connections and valve chamber		1	20.-	20.-
-Piping + connections from stop cock to tap(Ø 1")	m	3	3.-	9.-
-Tap		1	2.-	2.-
-Concrete foundation block	m^3	0.1	100.-	10.-
-Broken stone	m^3	0.2	15.-	3.-
				99.-
-Supervision, design, general overhead, management				p.m.

(All prices in US $) year

2. Single tap with support and platform (fig.12).

	Unit	Quantity	Cost incl. labour	
			per unit	total
-Connection on the main + service valve		1	15.-	15.-
-Service pipe (Ø 1/2")	m	20	2.-	40.-
-Stop cock, connections and chamber		1	20.-	20.-
-Watermeter		1		p.m.
-Piping and connections from stop cock to tap(Ø 1/2")	m	3	3.-	9.-
-Tap		1	2.-	2.-
-Concrete platform and support	m^3	0.7	150.-	105.-
-Broken stone	m^3	0.6	10.-	6.-
				197.-
-Supervision, design, general overhead, management				p.m.

(All prices in US $)

3. Single tap + platform + seepage pit (fig.12 + fig.20).

	Unit	Quantity	Cost incl. labour		
			per unit	total	
-Connection on the main + service valve		1	15.-	15.-	
-Service pipe (Ø 1/2")	m	20	2.-	40.-	
-Stop cock, connections and chamber		1	20.-	20.-	
-Watermeter		1		p.m.	
-Piping + connections from chamber to tap(Ø 1/2")	m	3	3.-	9.-	
-Tap		1	2.-	2.-	
-Concrete platform and support	m^3	0.8	150.-	120.- +	
-Total dispensing system					206.-
-Drainage pipe	m	5	5.-	25.-	
-Seepage pit:1 x 1 x 2 m^3 Excavation	m^3	10	2.-	20.-	
Masonry	m^3	1.6	60.-	96.-	
Broken stone	m^3	4	8.-	32.-	
Concrete cover	m^3	0.1	150.-	15.- +	
Total drainage system					188.-
Total Public Hydrant					394.- +
-Supervision, design, general overhead, management					p.m.

(All prices in US $)

4. Four taps, platform, raised platforms, seepage pit.(fig.19 + fig.20).

	Unit	Quantity	Cost incl. labour		
			per unit	total	
-Connection on the main + service valve		1	15.-	15.-	
-Service pipe (Ø 1")	m	20	2.20	44.-	
-Stop cock, connections and chamber		1	25.-	25.-	
-Watermeter		1		p.m.	
-Piping + connections from chamber to tap(Ø 1")	m	6	3.-	18.-	
-Tap		4	2.-	8.-	
-Concrete platform,support and raised platforms	m^3	2.5	150.-	375.- +	
-Total dispensing system					485.-
-Drainage pipe	m	5	5.-	25.-	
-Seepage pit:1,2x1,2x2 m^3 Excavation	m^3	12	2.-	24.-	
Masonry	m^3	2	60.-	120.-	
Broken stone	m^3	5	8.-	40.-	
Cover	m^3	0.1	150.-	15.- +	
-Total drainage system					224.-
Total Public Hydrant					709.- +
-Supervision, design, general overhead, management					p.m.

(All prices in US $)

5. Siphoide (fig. 3)

	Unit	Quantit	Cost incl. labour		
			per unit	total	
-Connection on the main incl. service valve		1	15.-	15.-	
-Service pipe (Ø 1/2")	m	20	2.-	40.-	
-Stop cock connections and chambers		1	20.-	20.-	
-Watermeter		1		p.m.	
-Piping connections from chamber to siphoide (Ø 1/2")	m	2	3.-	6.-	
-siphoide steel construction with internal piping, float valve, etc.		1	600.-	600.-	
-Platform (4 m^2) concrete	m^3	0.7	150.-	105.-	
				+	
-Total dispensing system					786.-
-Total drainage system					p.m.
-Supervision, design, general overhead, management					p.m.

(All prices in US $)

6. VAG Standpipe (Photograph 4) installed on a concrete platform.

	Unit	Quantity	Cost incl. labour		
			per unit	total	
-Connection on the main + service valve		1	15.-	15.-	
-Service pipe (Ø 3/4")	m	20	2.20	44.-	
-Stop cock, connections and chamber		1	20.-	20.-	
-Watermeter		1		p.m.	
-Piping + connections from chmaber to standpipe (Ø 3/4")	m	2	3.-	6.-	
-VAG standpipe		1	800.-	800.-	
-Concrete platform(4 m^2)	m^3	0.6	150.-	90.- +	
-Total dispensing system					975.-
-Total drainage system					p.m.
-Supervision, design, general overhead, management					p.m.

(All prices in US $)

7. Approximate prices of different types of taps.

-Ordinary tap (Ø 1/2")	US $ 2.-	
-Ordinary ball valve (Ø 1/2")	10.-	
-Springloaded and gravity operated tap (such as the Jayson tap) (Ø 1/2")	5.-	to 10.-
-Selfclosing tap (such as Tylor "Wastenot", Fordilla and Edward Barber "Aquatrol")	15.-	to 20.-

ANNEX 3.

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REFERENCES

ANNEX 3.

1. Projet d'aménagement et d'entretien des bornes fontaines dans les quartiers non urbanisés de Libreville. Société d'Energie et d'Eau du Gabon - 1972

2. SEEG. Statistiques Analytiques d'Eau du Gabon - 1973

3. Statistiques Générales Electricité et Eau au Gabon - 1973 SEEG - 1974

4. Seven Urban Water Supply Schemes in Ghana. Howard Humphreys & Sons, 1970. Prepared for the World Health Organization.

5. Informations et Documents BCEOM - 1973 - no. 10 Les bornes fontaines en milieu tropicale Africain.

6. World Health Statistics - W.H.O.- Geneva. Vol. 26, No. 11, 1973

7. Village Water Supply and Sanitation in Less Developed Countries. R.J. Saunders and J.J. Warford.

8. Water Supply for Rural Areas and Small Communities. E.G. Wagner and J.N. Lanoix, WHO Geneva 1959.

9. The hydraulic design of Fordilla pods. Richard V. Ford.

10. New concept in Water Service for Developing Countries. E.K.G. Borjesson and C.M. Bobeda. Journal of American Waterworks Association, Vol. 56, No. 7 - 1964.

11. Individual household water supplies in Rural St. Lucia as a control measure against Schsitsoma mansoni. G.O. Unrau (concept report)

12. World Health Organization - "The village tank as a Source of Drinking Water".

13. Projet d'Eau et d'Assainissement au Mali. Balfour & Sons and ACWA - 1973 (Prepared for W.H.O.) L'étude Sectorielle d'Eau Projet d'Adduction d'Eau de Sikasso, Koutiala, San

14. Alimentation en Eau Potable de la Ville de Ségou (Mali) Prepared by SEURECA for the FED. Rapport socio-économique - Avant Projet Technique

15. Rural Sanitation in the Tropics. The Ross Institute. Bulletin no. 8 - 1965

16. Les Approvisionnements Publics en Eau. Rapport d'un Comité d'experts de l'O.M.S. Série de Rapports Techniques no. 420 - 1969

17. Small Water Supplies The Ross Institute. Bulletin no. 10 - 1964

18. A progress Report on the Zaina Environmental Sanitation Scheme.
K.W.H. Fenwick, Nyeri (Kenya) - 1966

19. République du Sénégal - Projet 22 - préparé pour l'O.M.S.
Plan Directeur de l'Approvisionnement en Eau de Dakar.
Etudes Sociologiques

20. World Health Organization - Community and Rural Water Supply,
Sewerage and Water Pollution Control.
Report No. 2 - 1972 - Government of Kenya

21. Drawers of Water.
G.F. White, D.J. Bradley, A.U. White. - 1972

22. Water Supply, Sewerage, Drainage and Solid Waste Systems for
Greater Kabul, Republic of Afganistan.
W.H.O. - U.N.D.P. - Proctor & Redfern

23. Survey of the distribution systems of the Greater Kathmandu
and Bhaktapur - 1973 - W.H.O. - U.N.D.P. Project Nepal.
Binnie & Partners

24. Masterplans for Water Supply and Sewerage for the Greater
Kampala and Jinja Areas, Republic of Uganda.
W.H.O. - U.N.D.P. - 1971 - Resources Group

25. Pakistan Water Supply and Sewerage Sector Study.
I.B.R.D. - I.D.A. - W.H.O. - 1974

26. India, Water Supply and Sanitation Sector Surveys - 1972 I.O.A./WHO

27. Peoples Republic of Bangladesh.
Water Supply and Sewerage Sector Study - 1973
I.B.R.D./I.D.A./W.H.O.

28. India, Madhya Pradesh, Rural Water Supply. Masterplan - W.H.O.

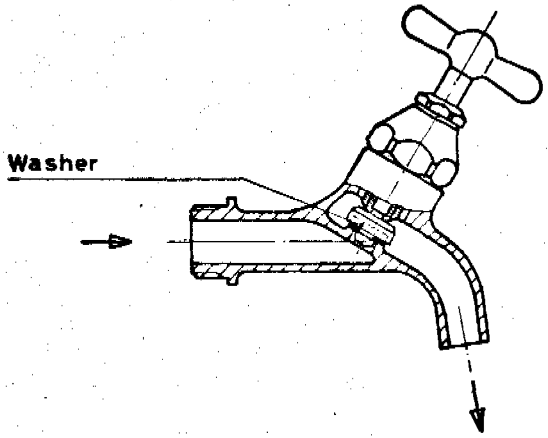
29. Iraq, Rural Water Supply Development Plan.
U.N.D.P./W.H.O. - 1974 - Ward, Ashcroft & Parkman.

30. W.H.O. - Visit Reports:
- Venezuala 1972
- Columbia 1972
- Peru 1972
- Argentinia 1972
- Upper Volta 1972

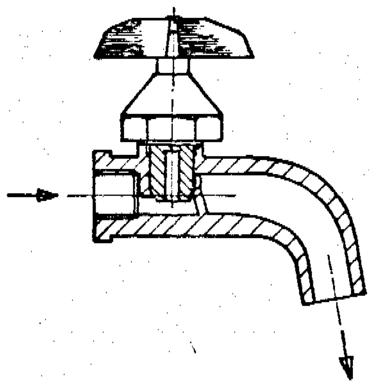
31. W.H.O. - Sector Briefs:
- Costa Rica 1974
- El Salvador 1974
- Honduras 1974
- Nicaragua 1974
- Sudan 1973

FIGURES

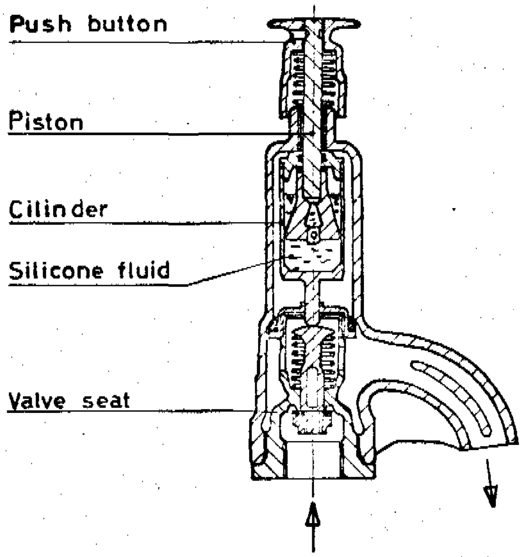
LIST OF FIGURES:



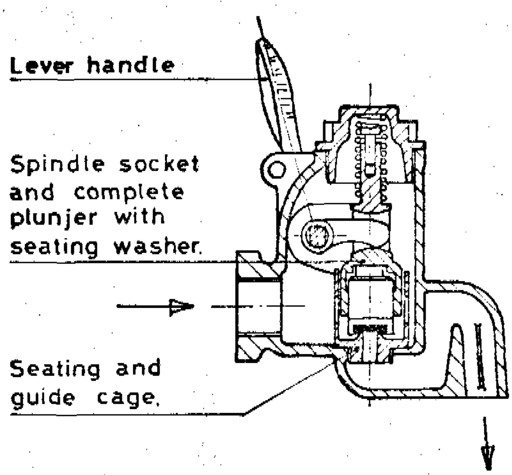
A: Ordinary tap.
In closed position.



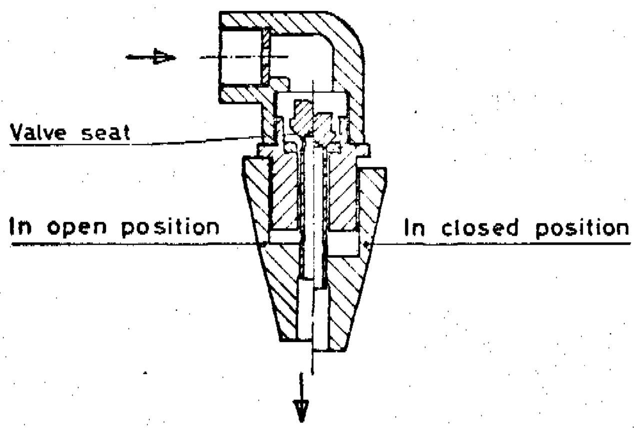
B: Nylon tap.
In closed position.



C: Self closing tap.
(Fordilla)
In closed position.

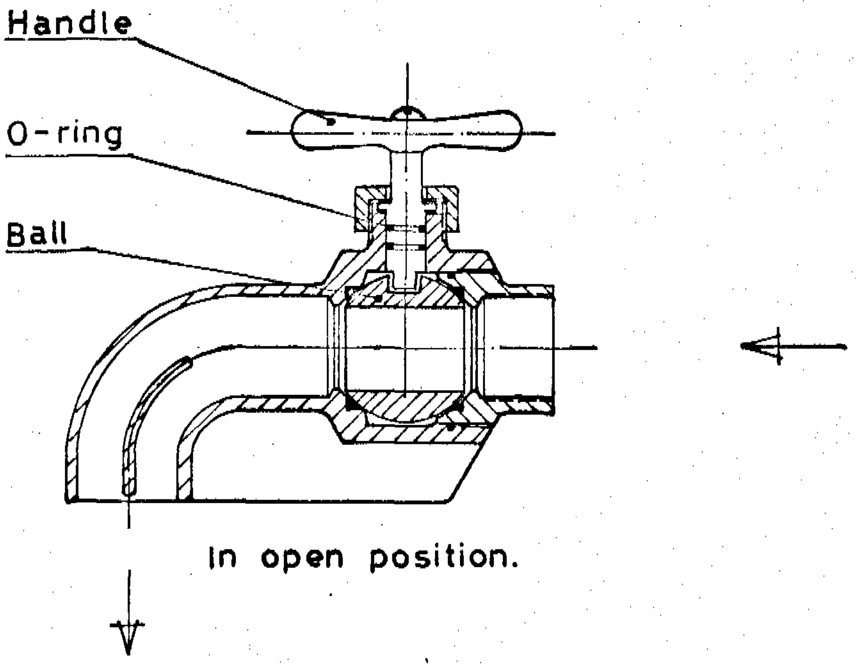


D: Self closing tap.
(Tylor wastenot)
In closed position.

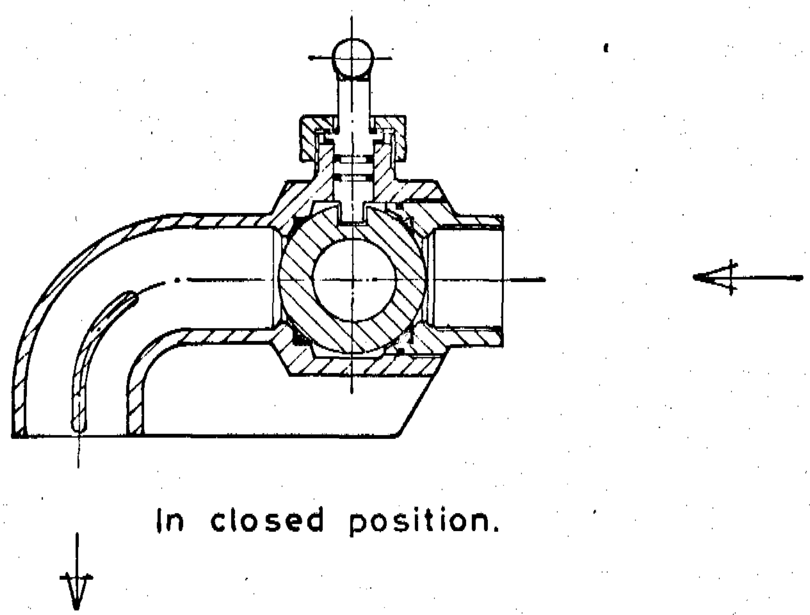


E: Gravety operated tap.
(Jayson (Pat) water Taps).

Examples of existing taps. Fig. 1

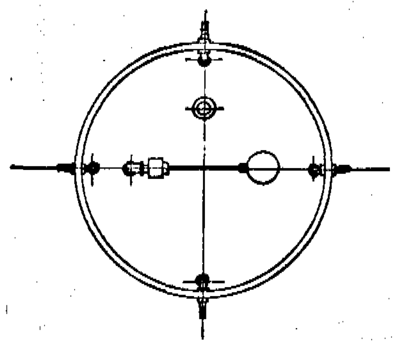


In open position.

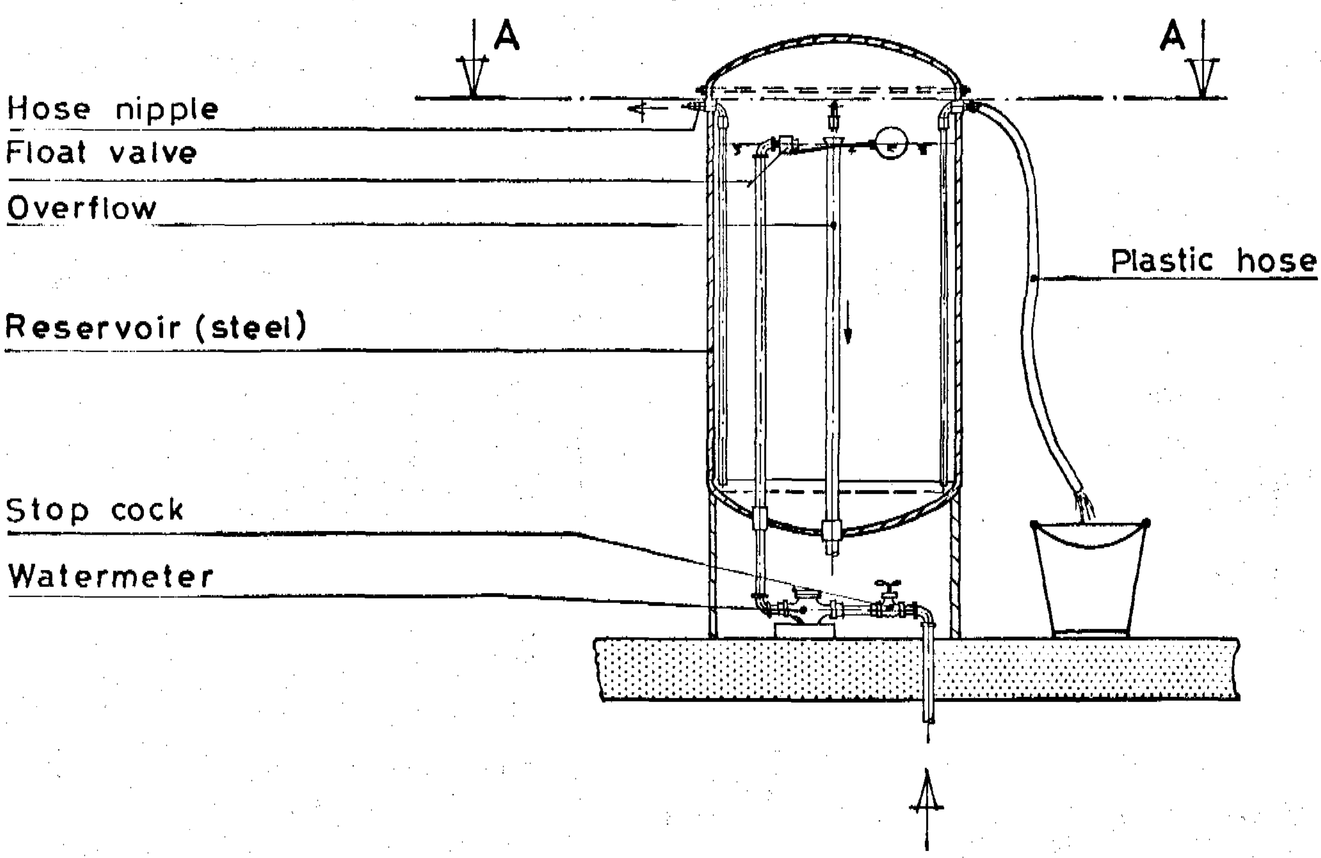


In closed position.

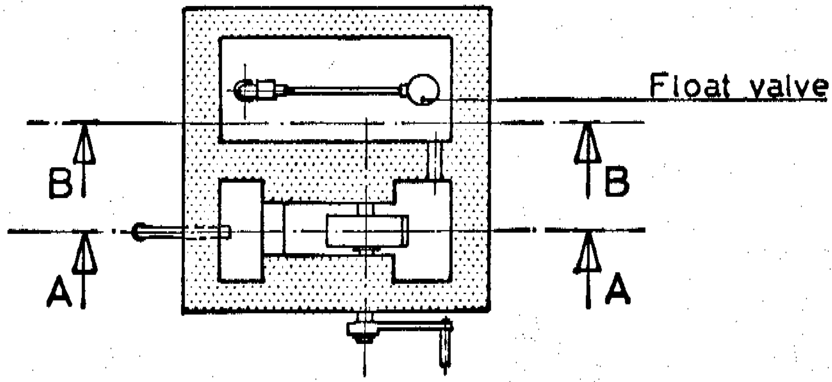
Suggested tap with ball valve fig. 2



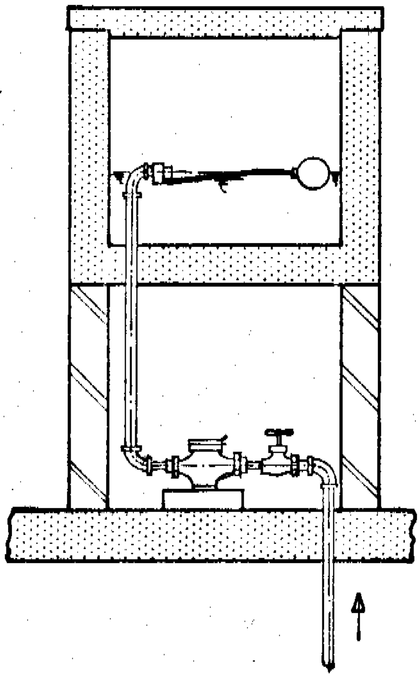
Cross Section A-A



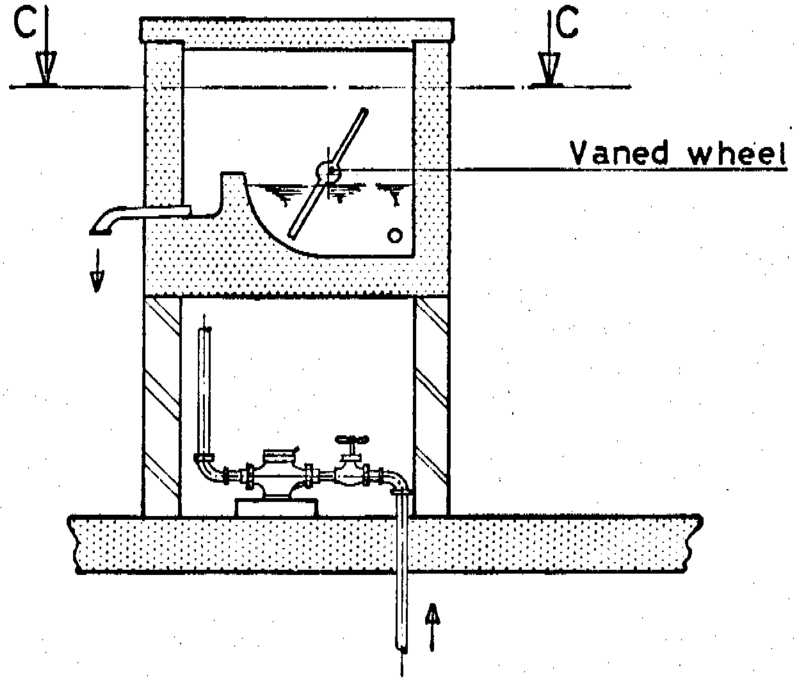
Siphoide Fig. 3



Cross section C-C

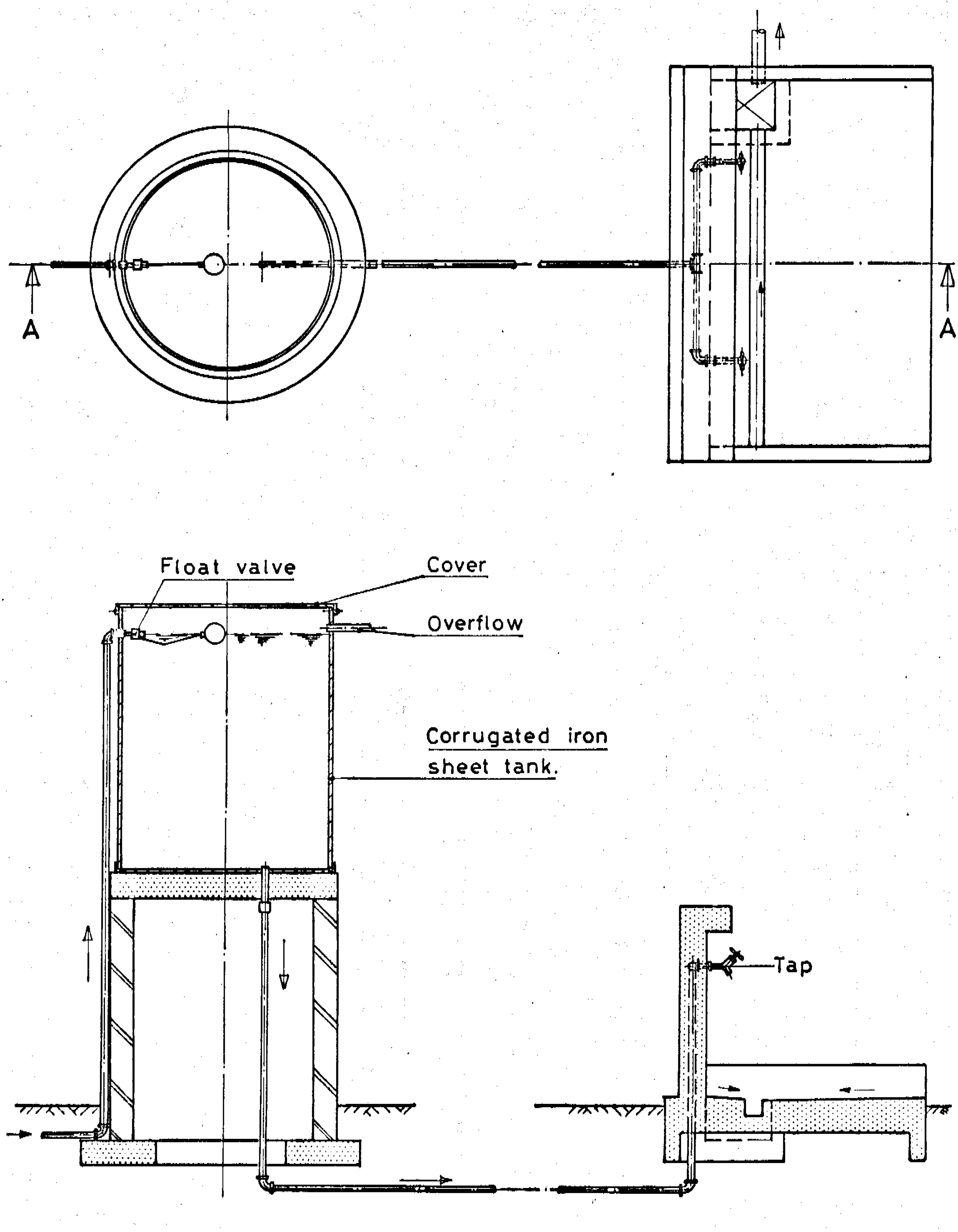


Cross section B-B



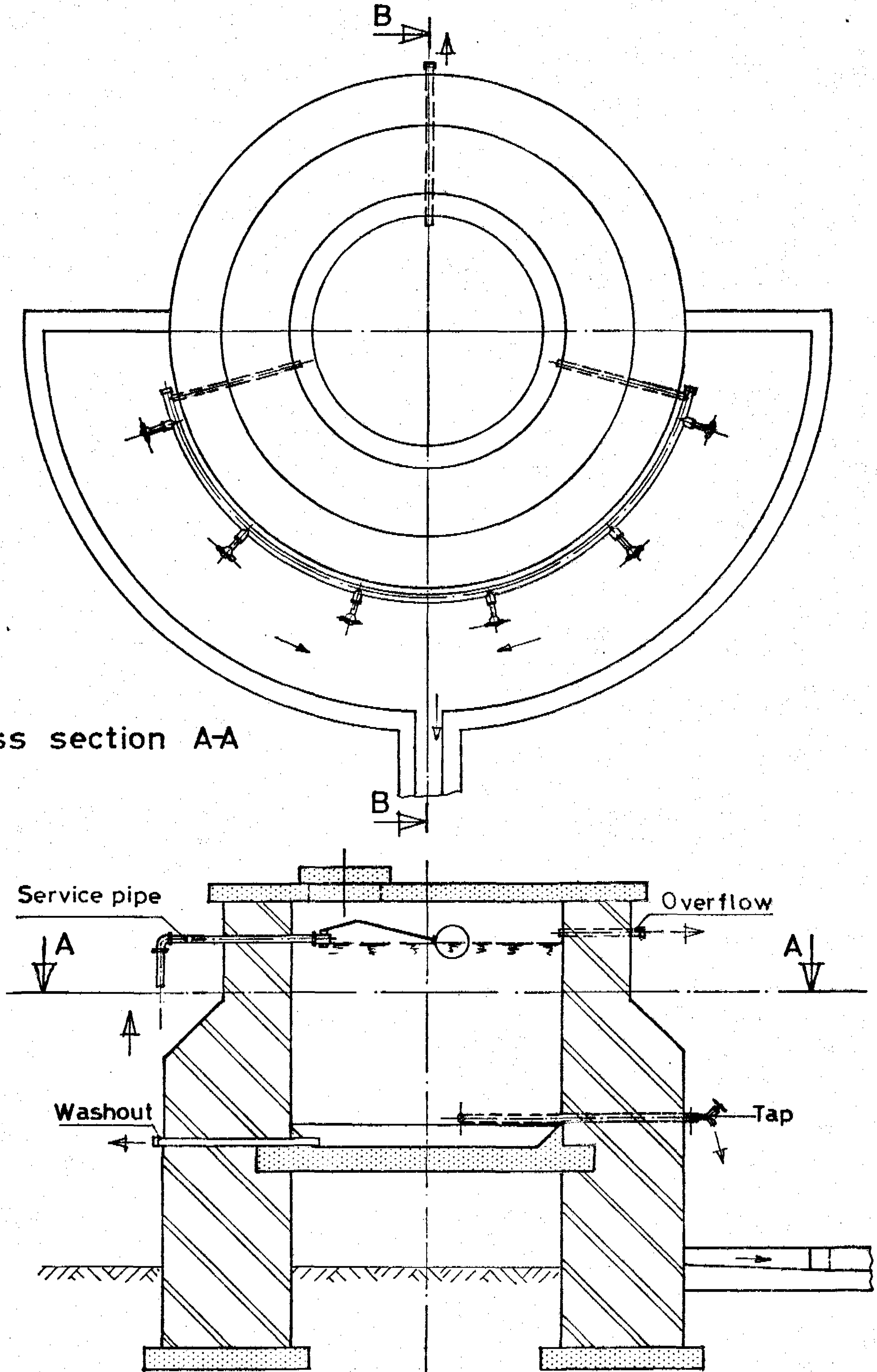
Cross section A-A

Bedouin type. Fig. 4



Cross section A-A

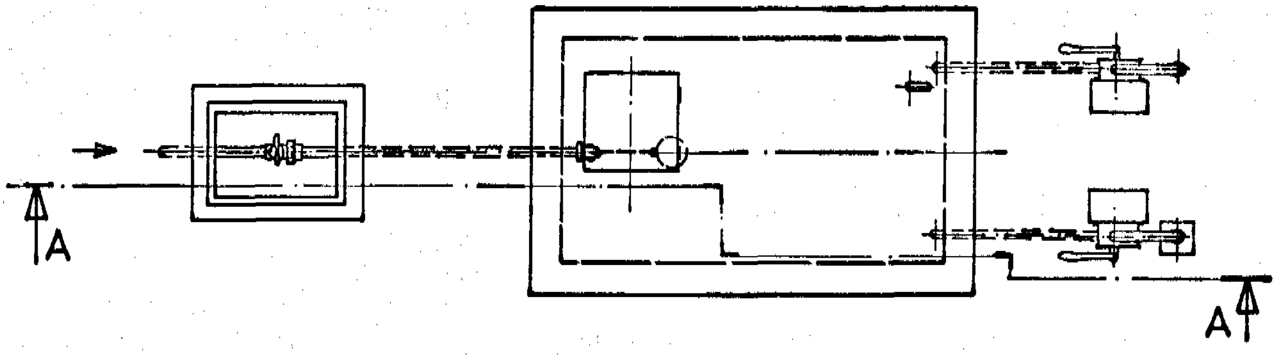
Public hydrant with corrugated iron sheet tank. Fig. 5

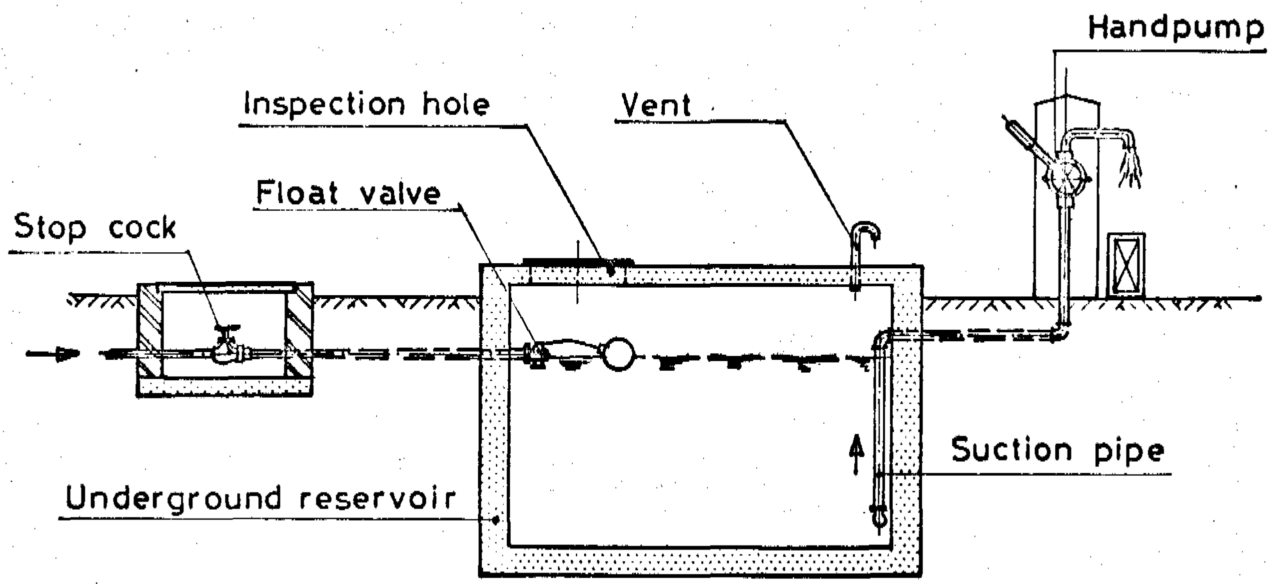


Cross section A-A

Cross section-B B

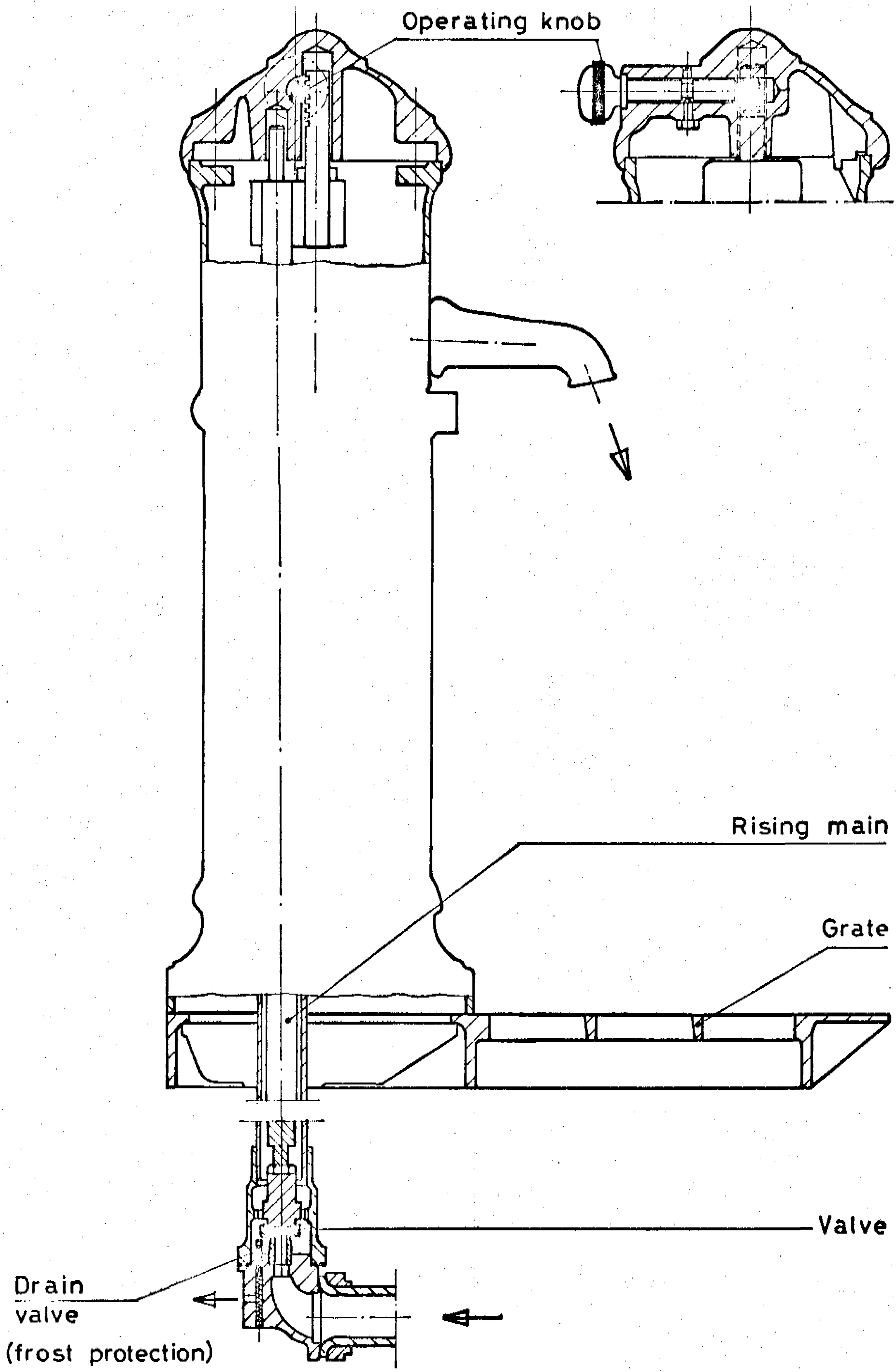
Overground reservoir . Fig. 6



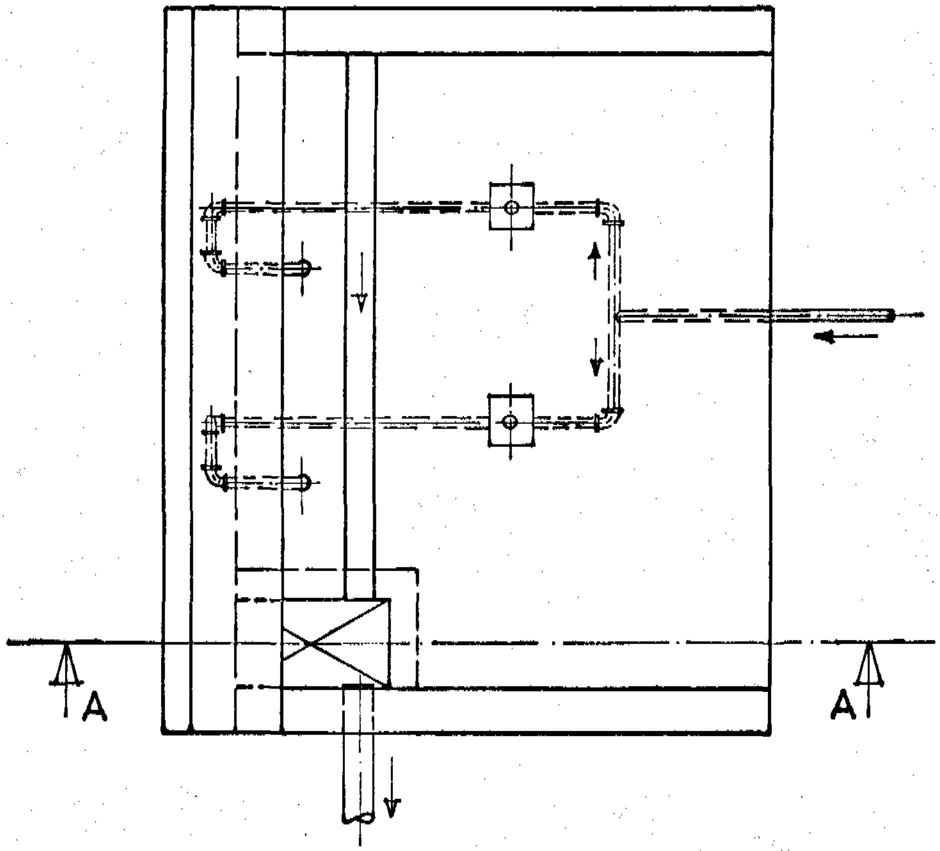


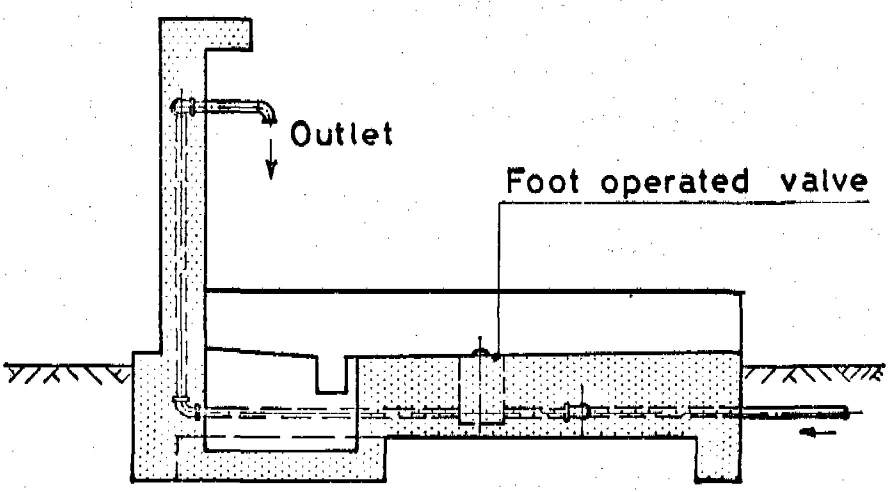
Cross section A-A

Underground reservoir with handpump .Fig. 7



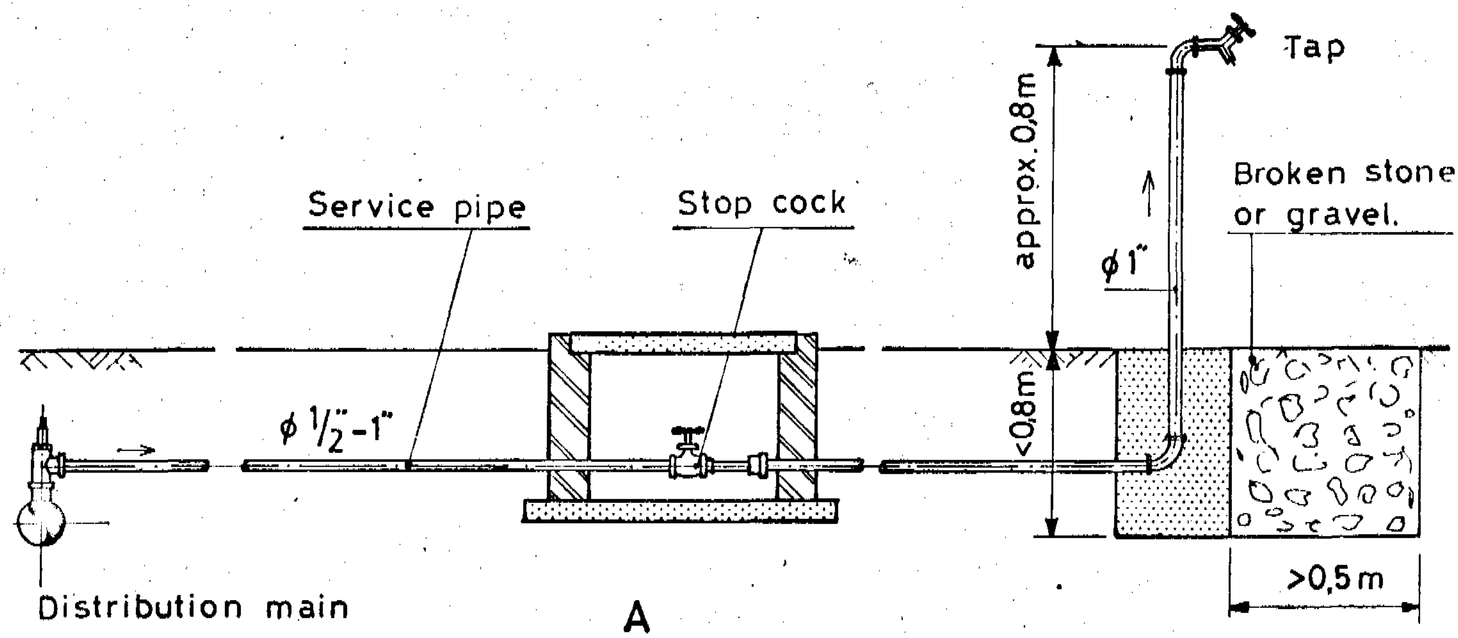
Neptune type. Fig. 8

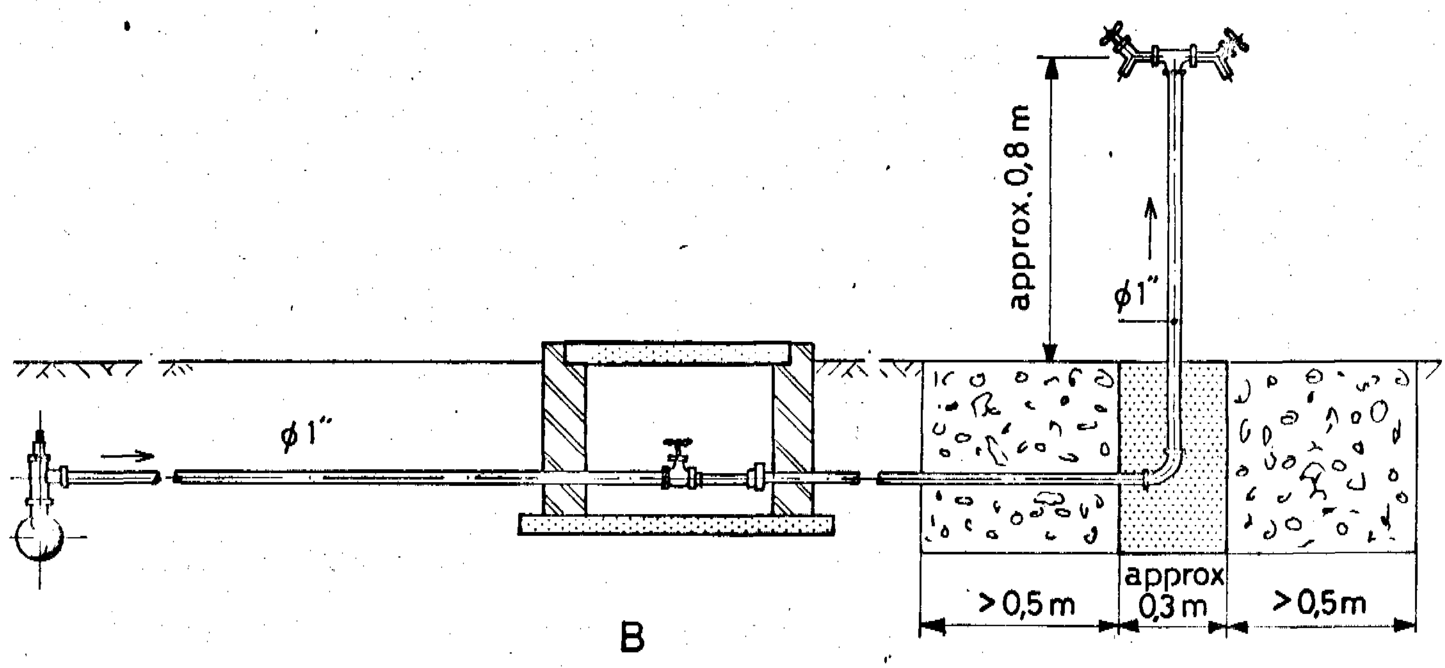




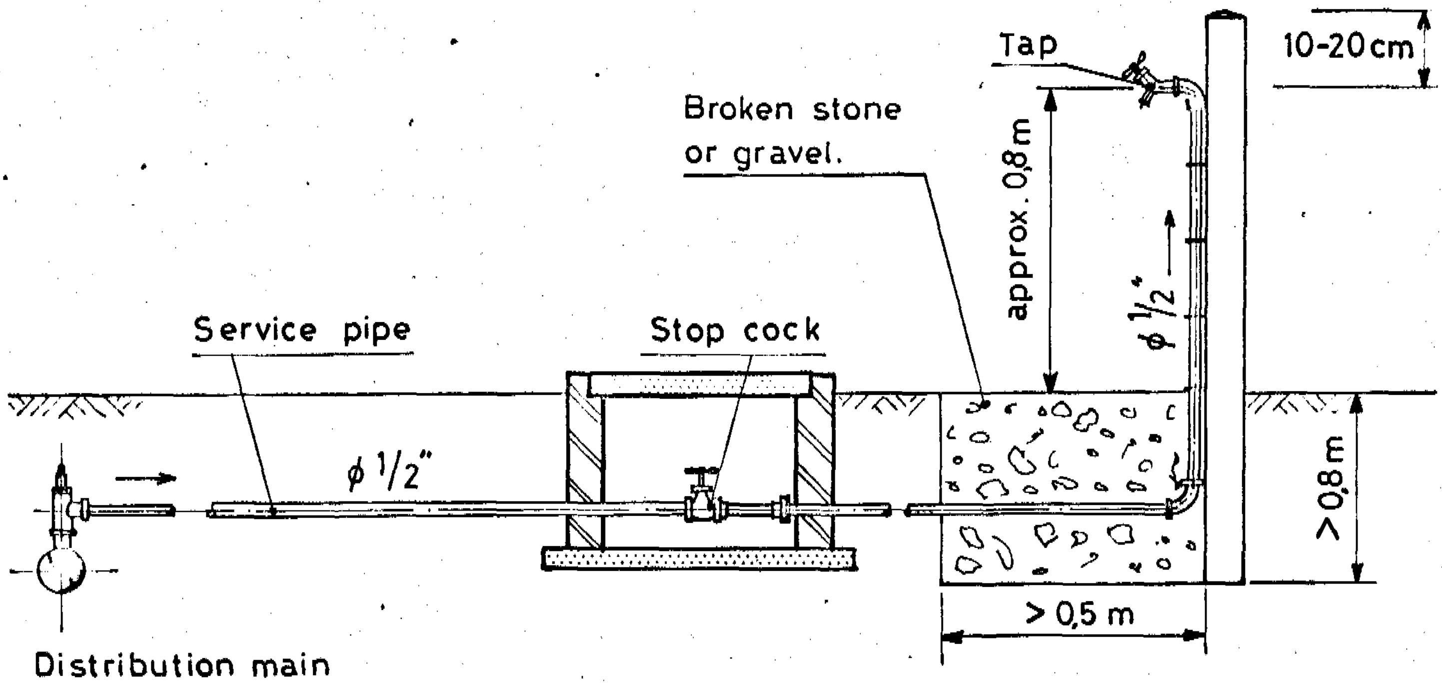
Cross section A-A

Public hydrant with foot operated valves. Fig. 9

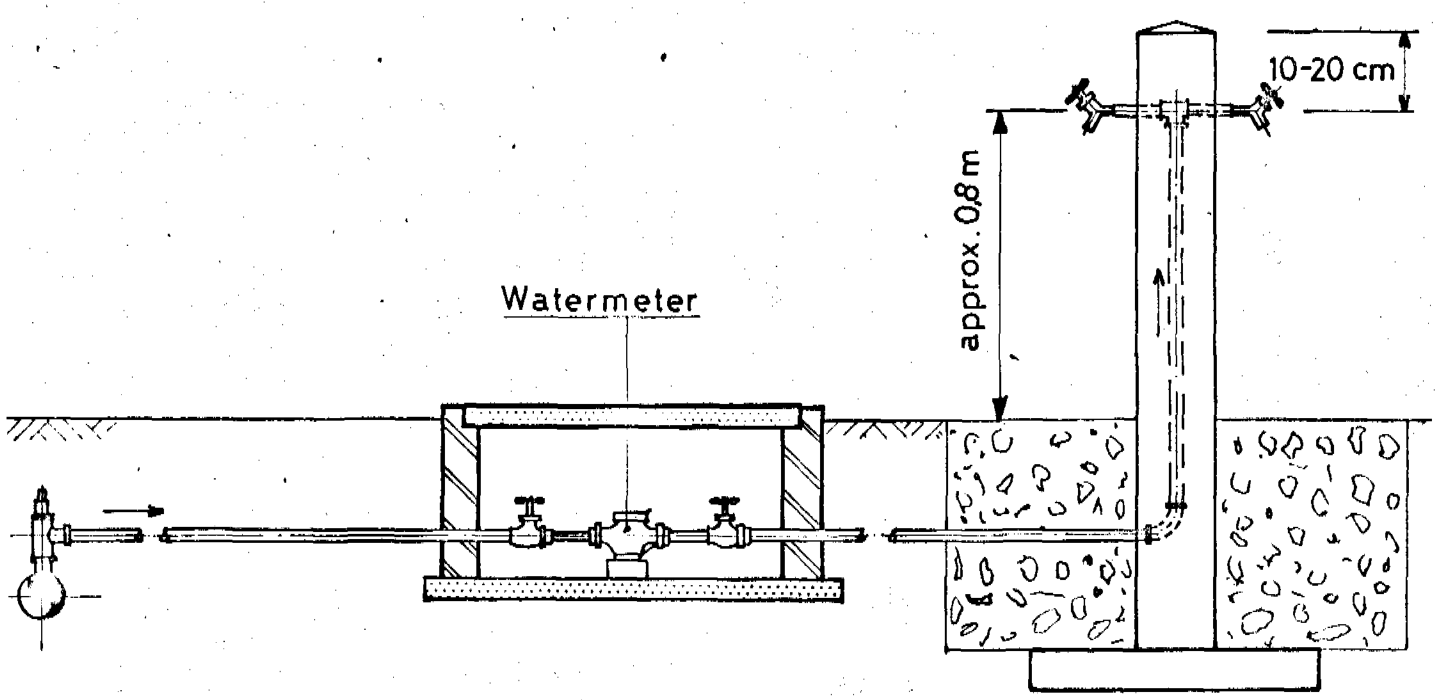




Unsupported rising pipe with one or two taps. Fig.10

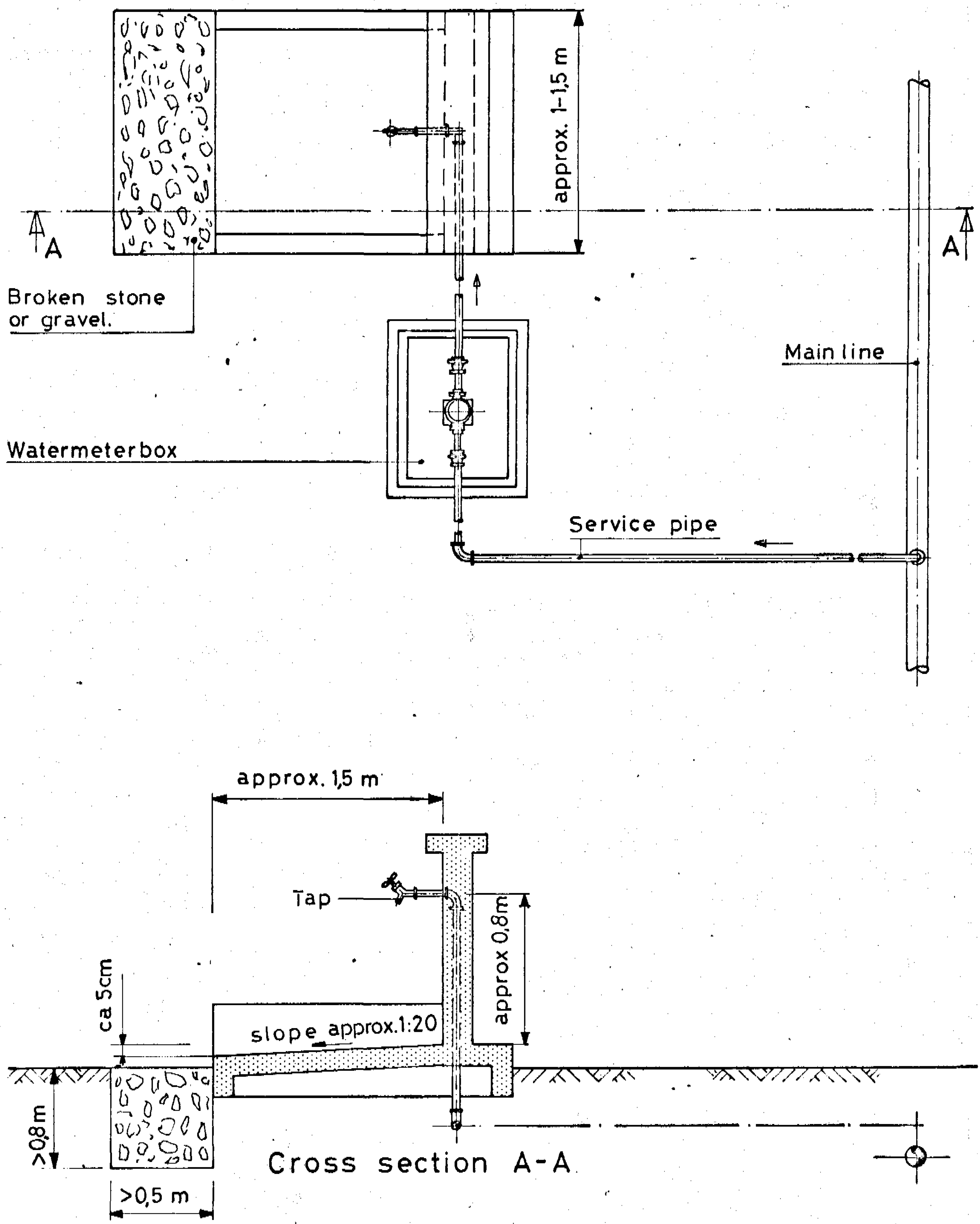


A

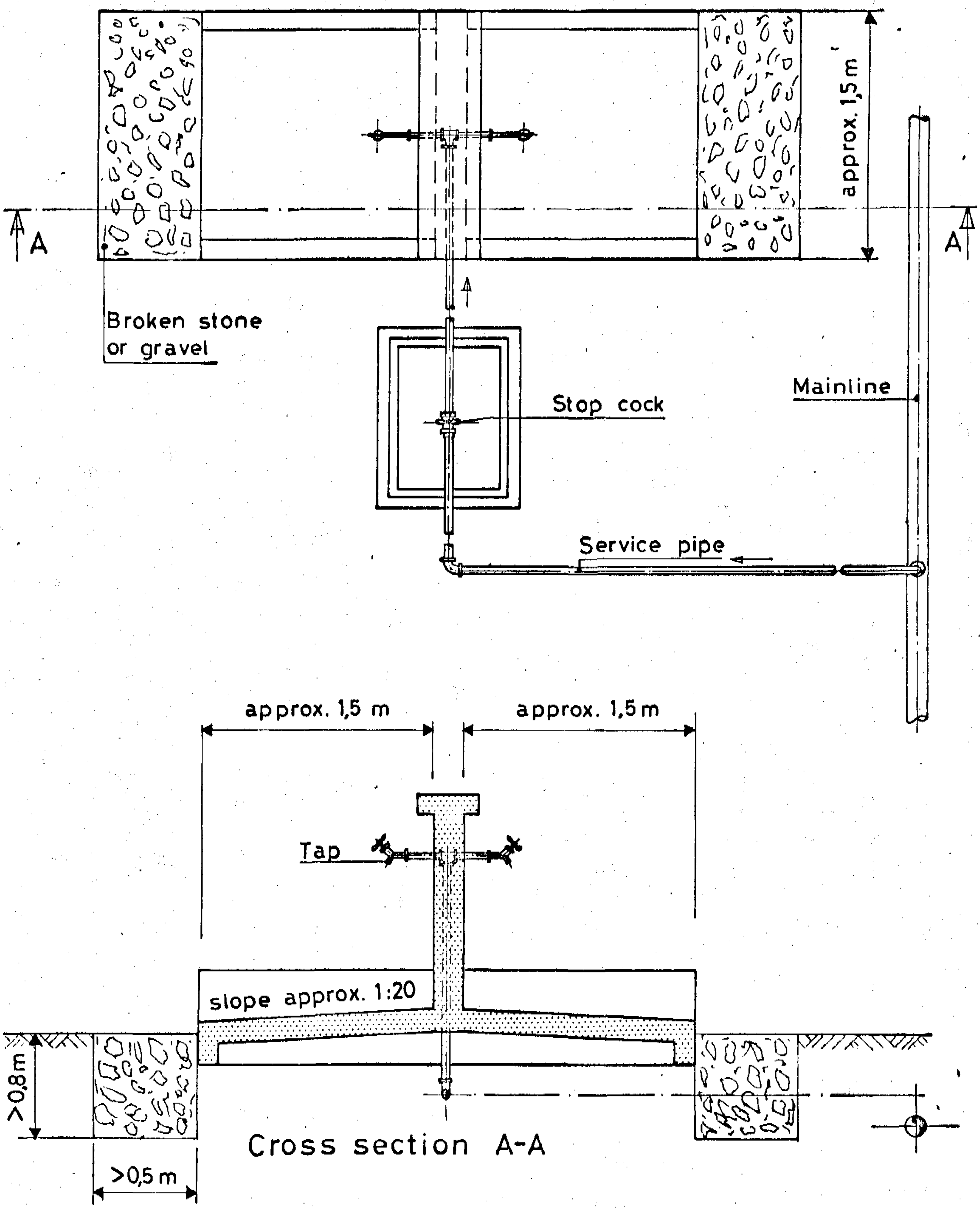


B

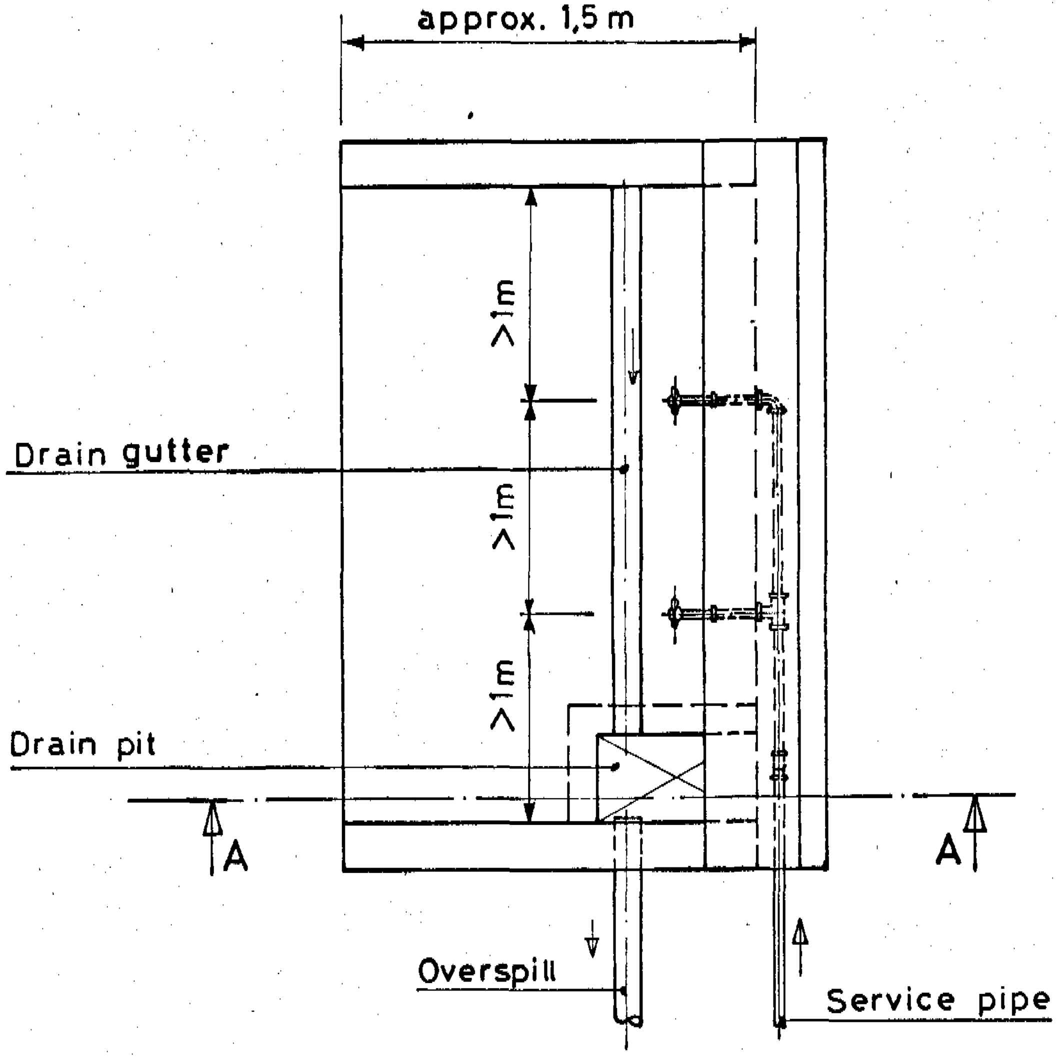
Rising pipe supported by a concrete post. Fig. 11

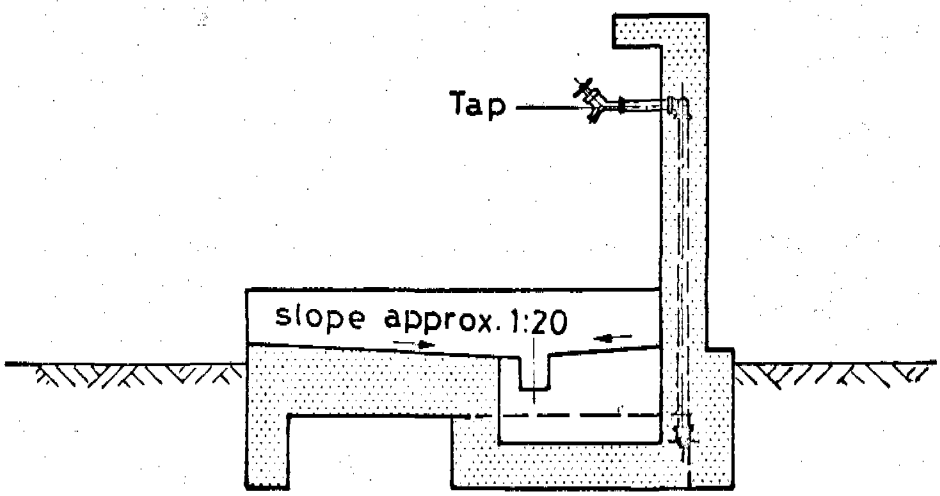


Single tap with support and platform. Fig. 12



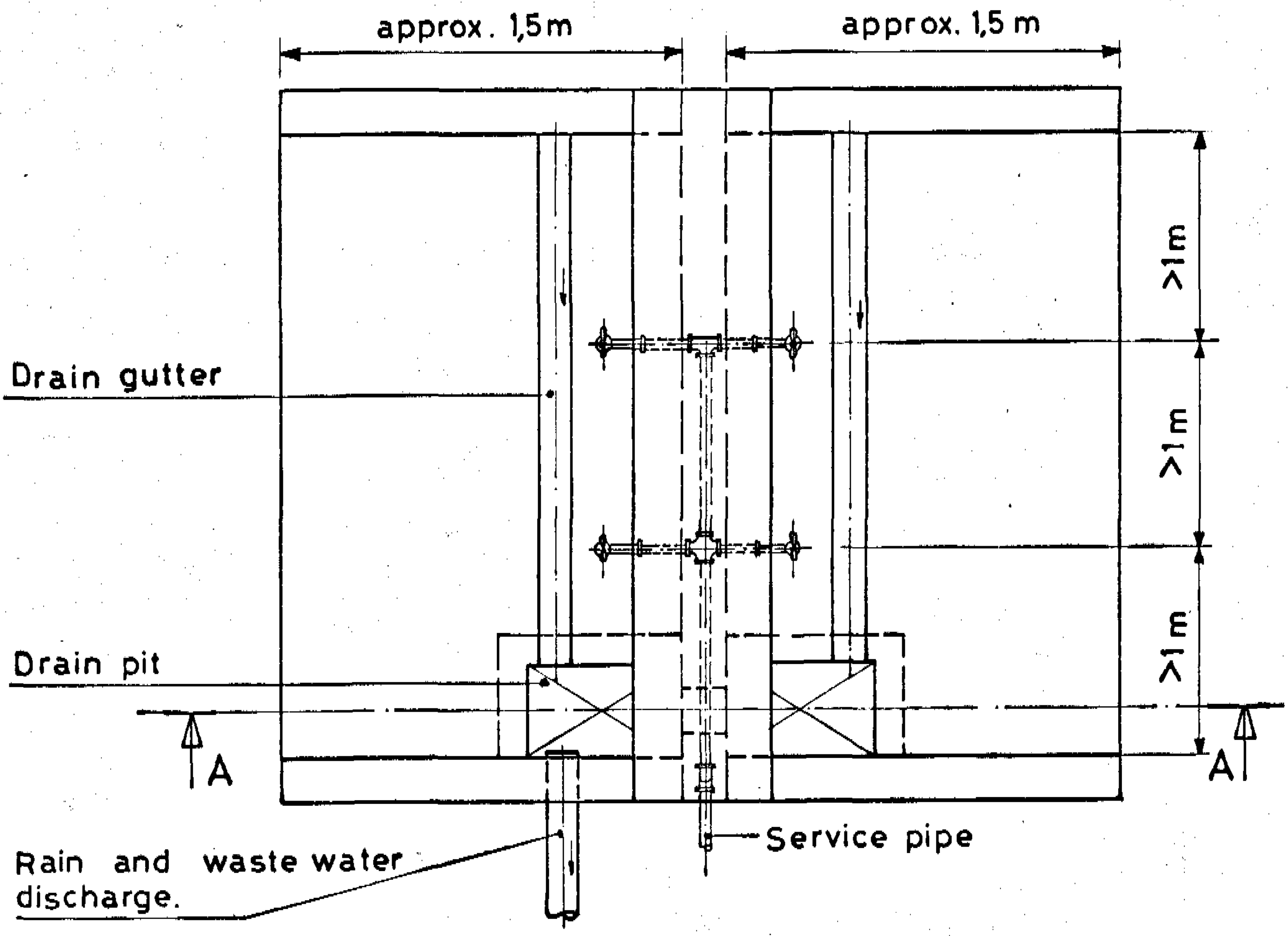
Two taps with support and platform Fig. 13

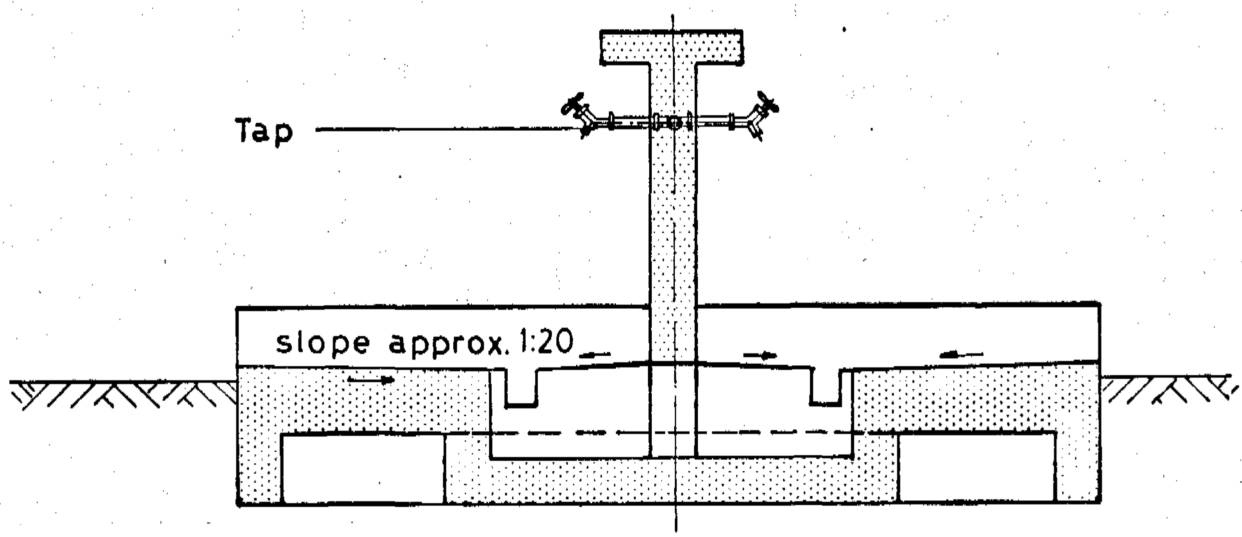




Cross section A-A

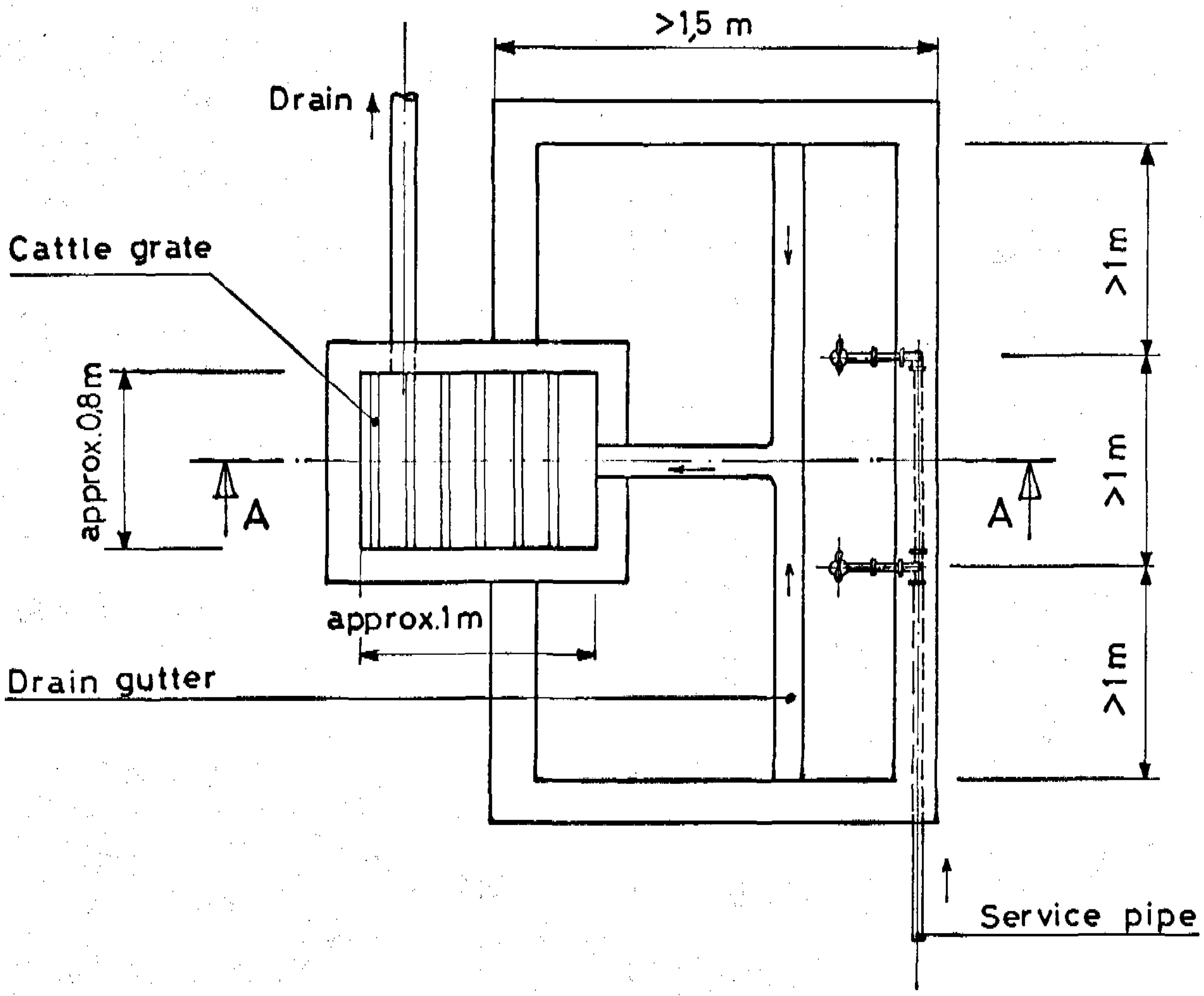
Two taps with support and platform. Fig. 14

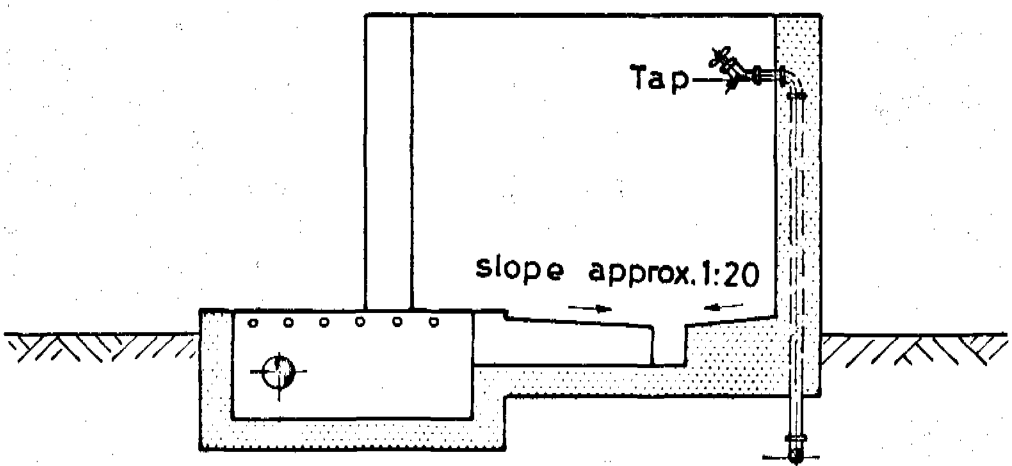




Cross section A-A

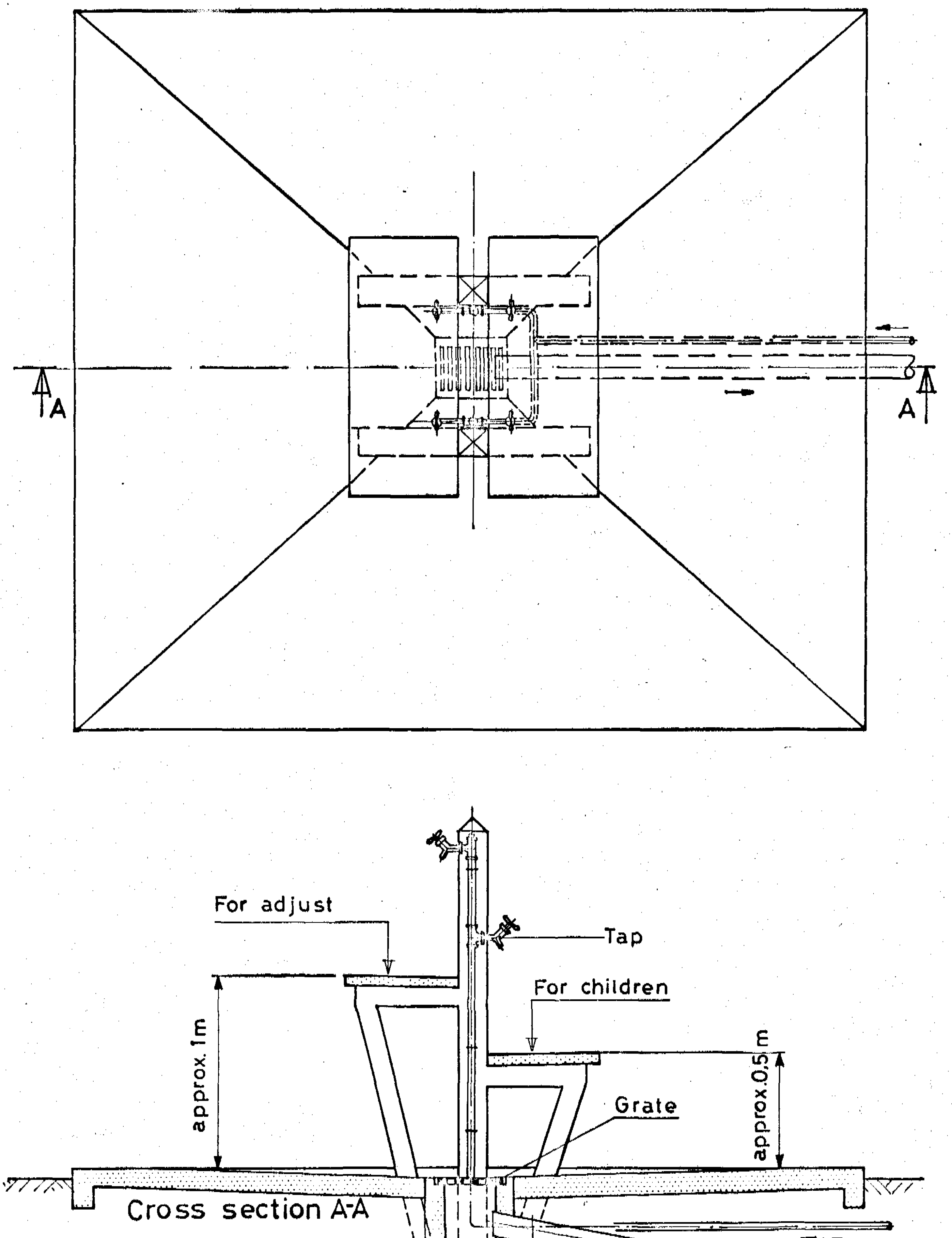
Arrangement of four taps. Fig. 15



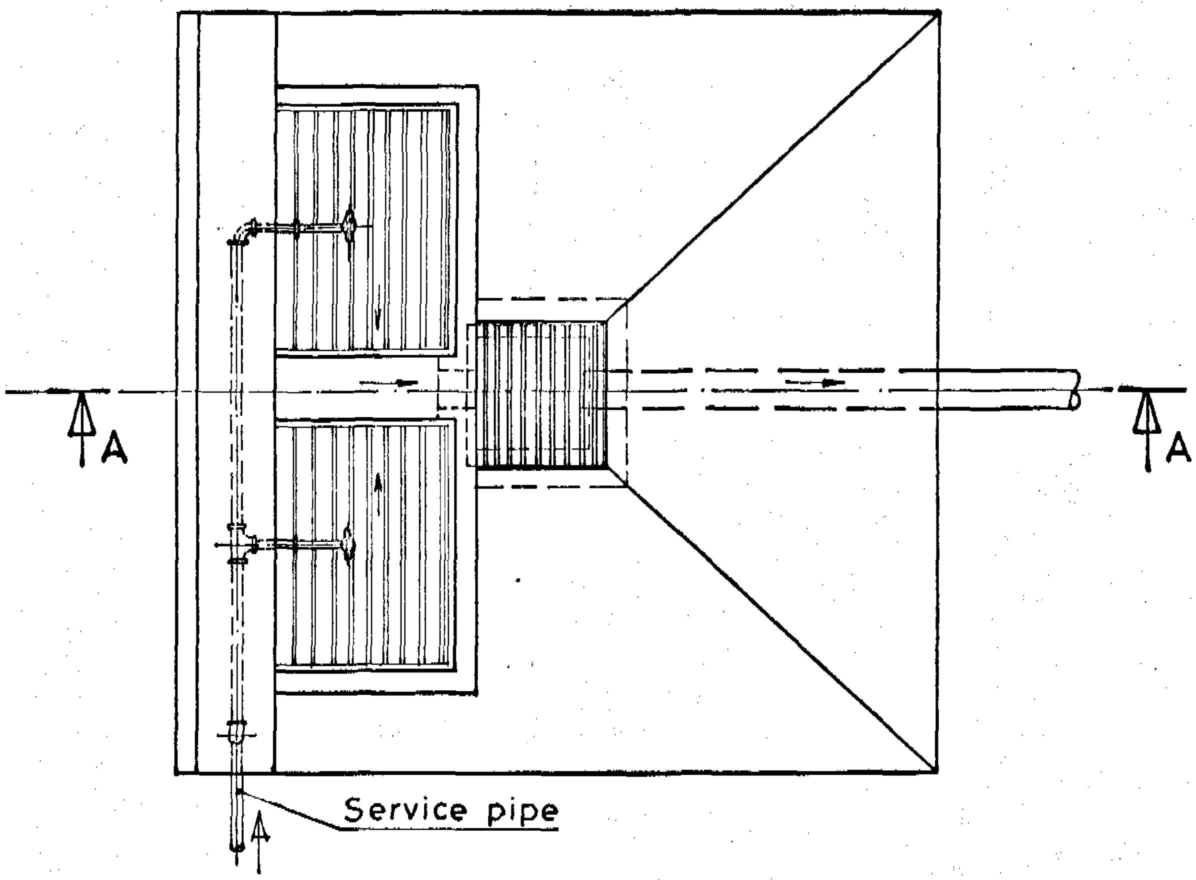


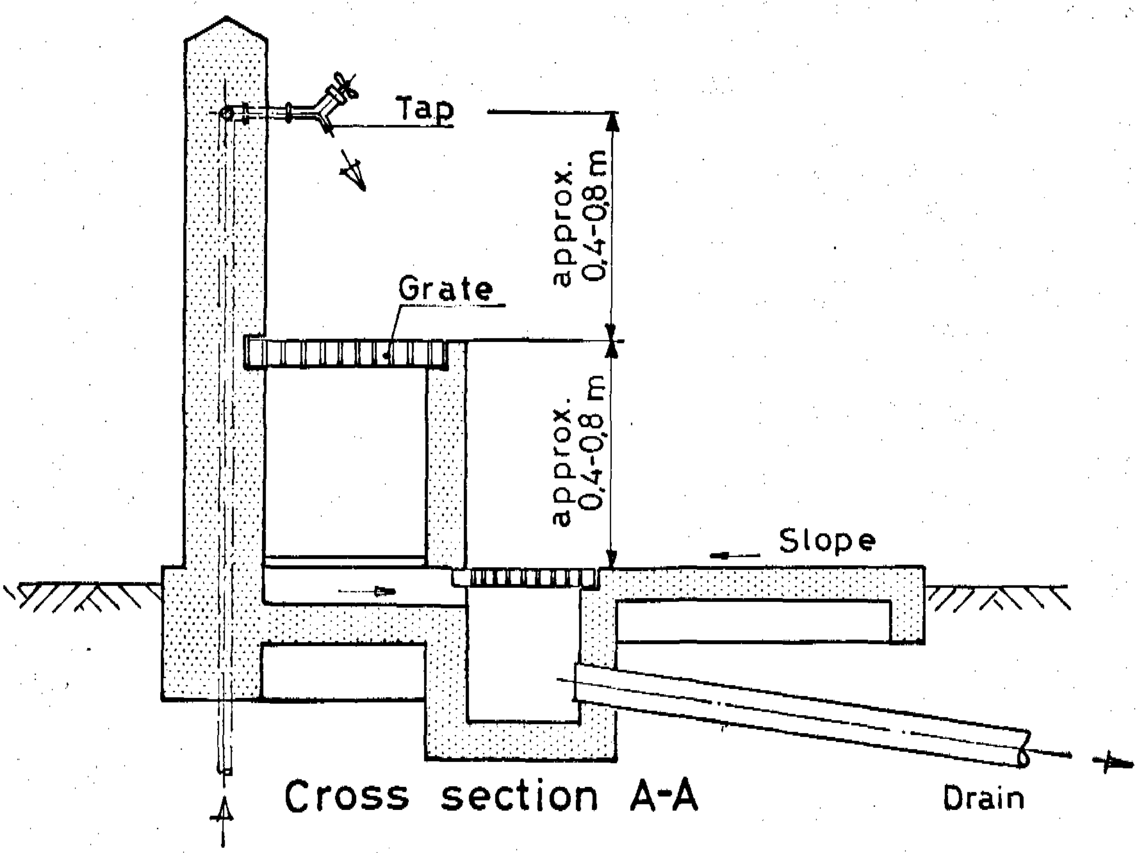
Cross section A-A

Two taps with platform,
surrounding wall, protection against cattle. Fig. 16



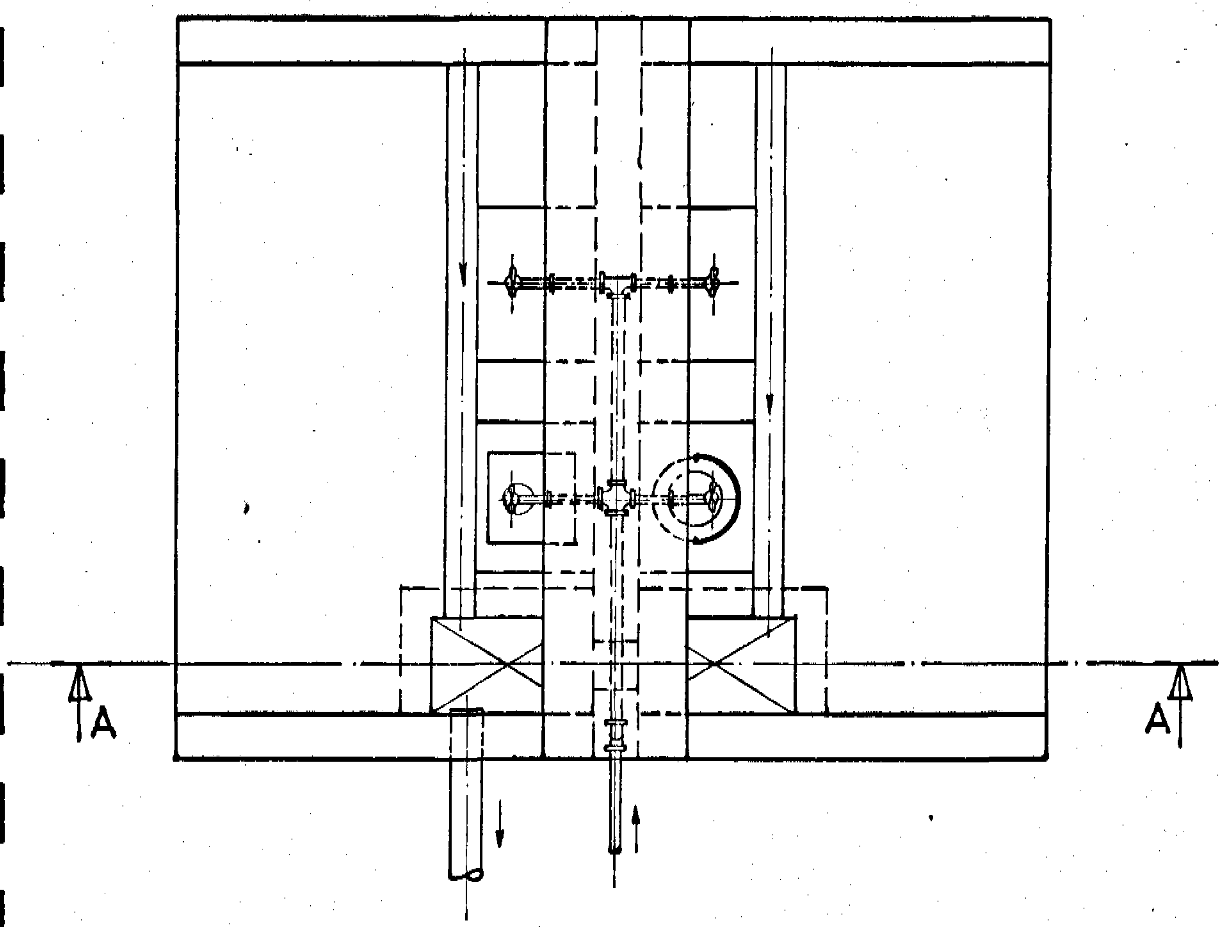
Raised platforms for containers on different levels.(proposed for Dakar) Fig.17

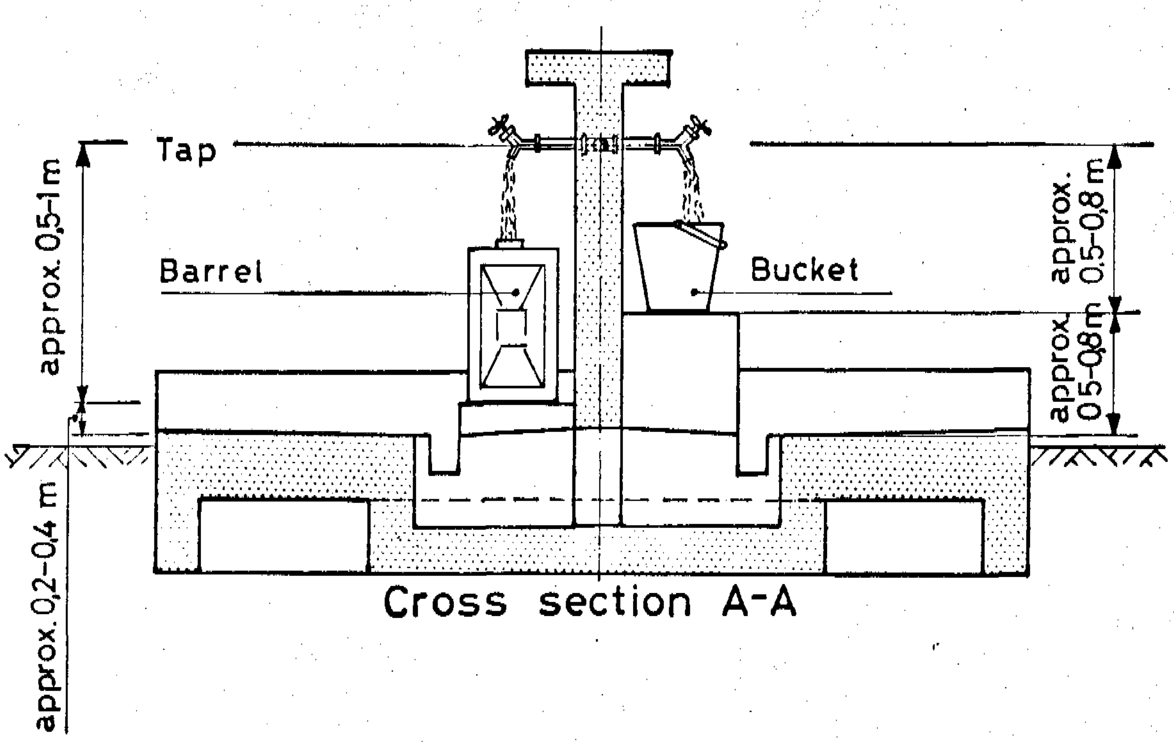




Cross section A-A

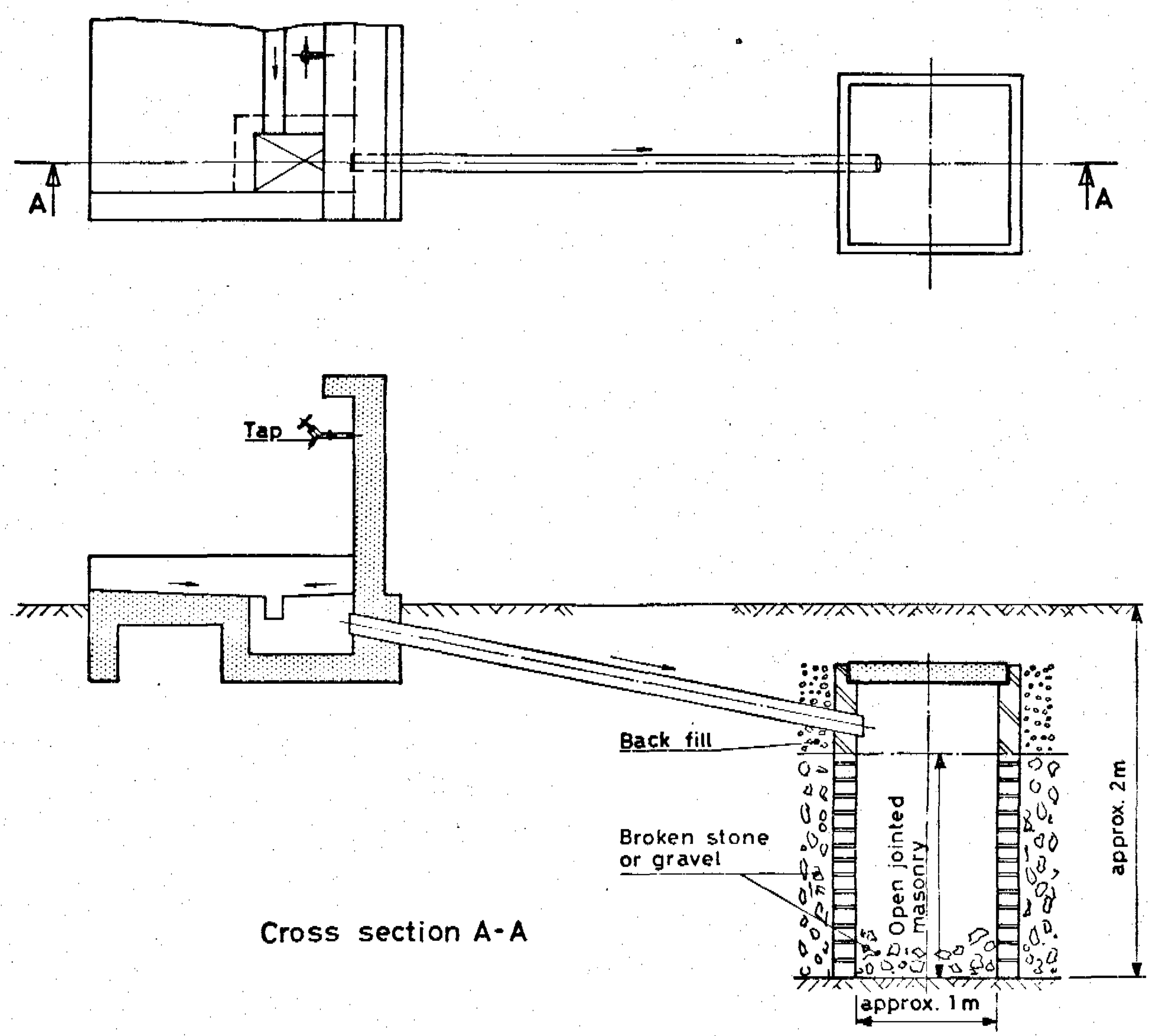
Raised platforms for debbies with grate Fig.18



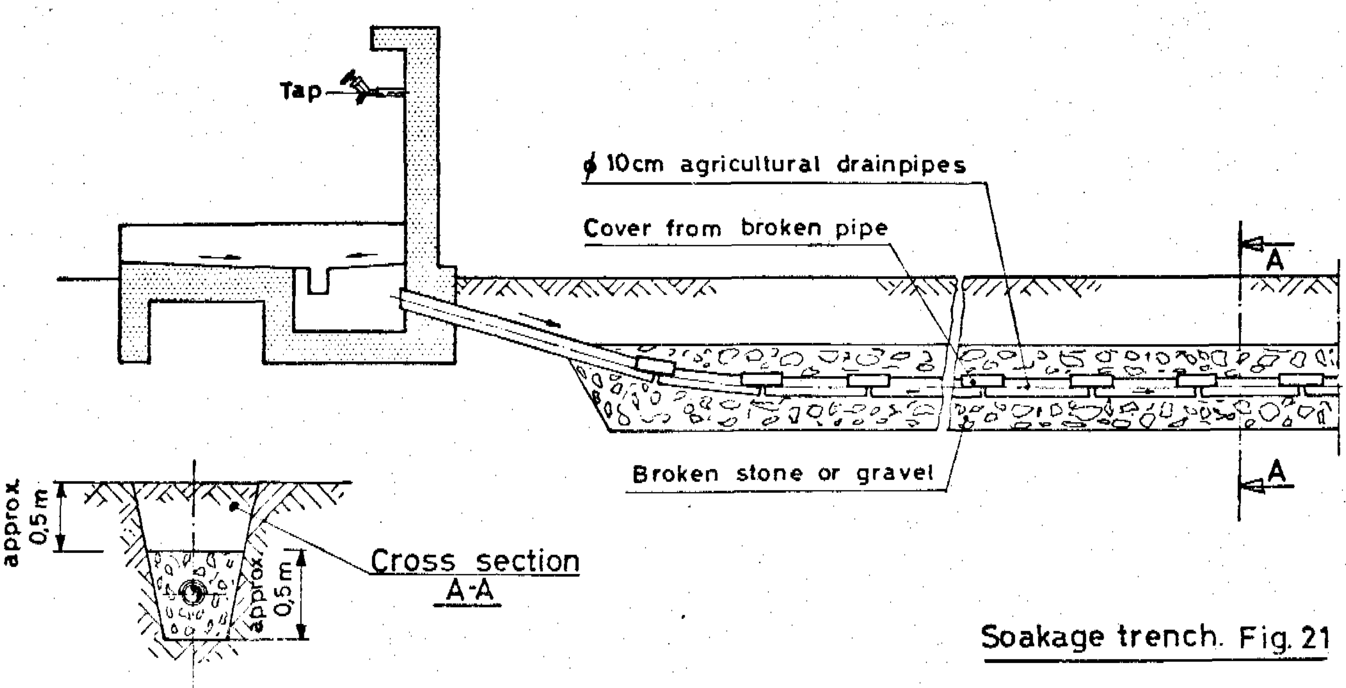


Cross section A-A

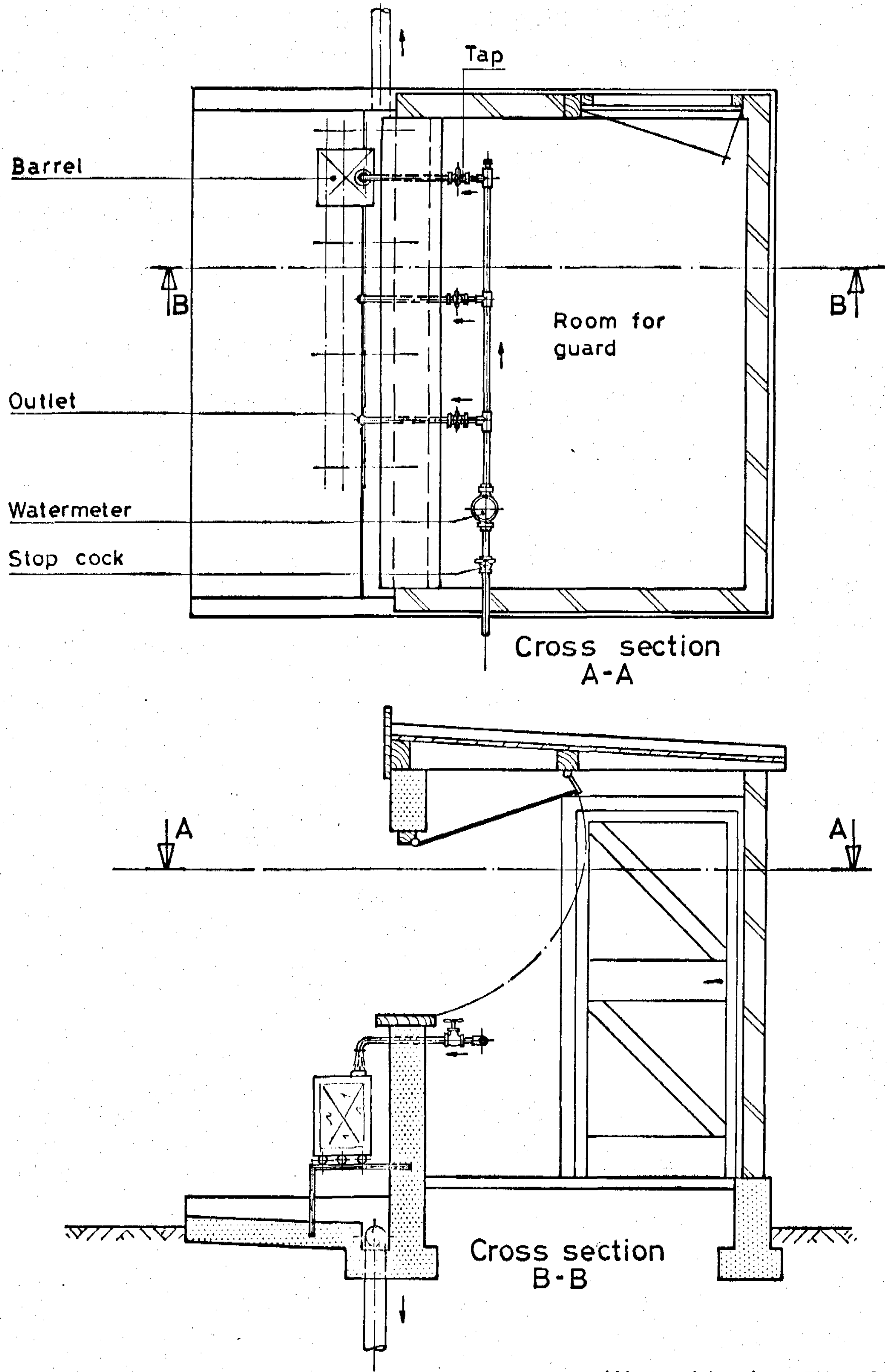
Raised platforms for debbies. Fig. 19



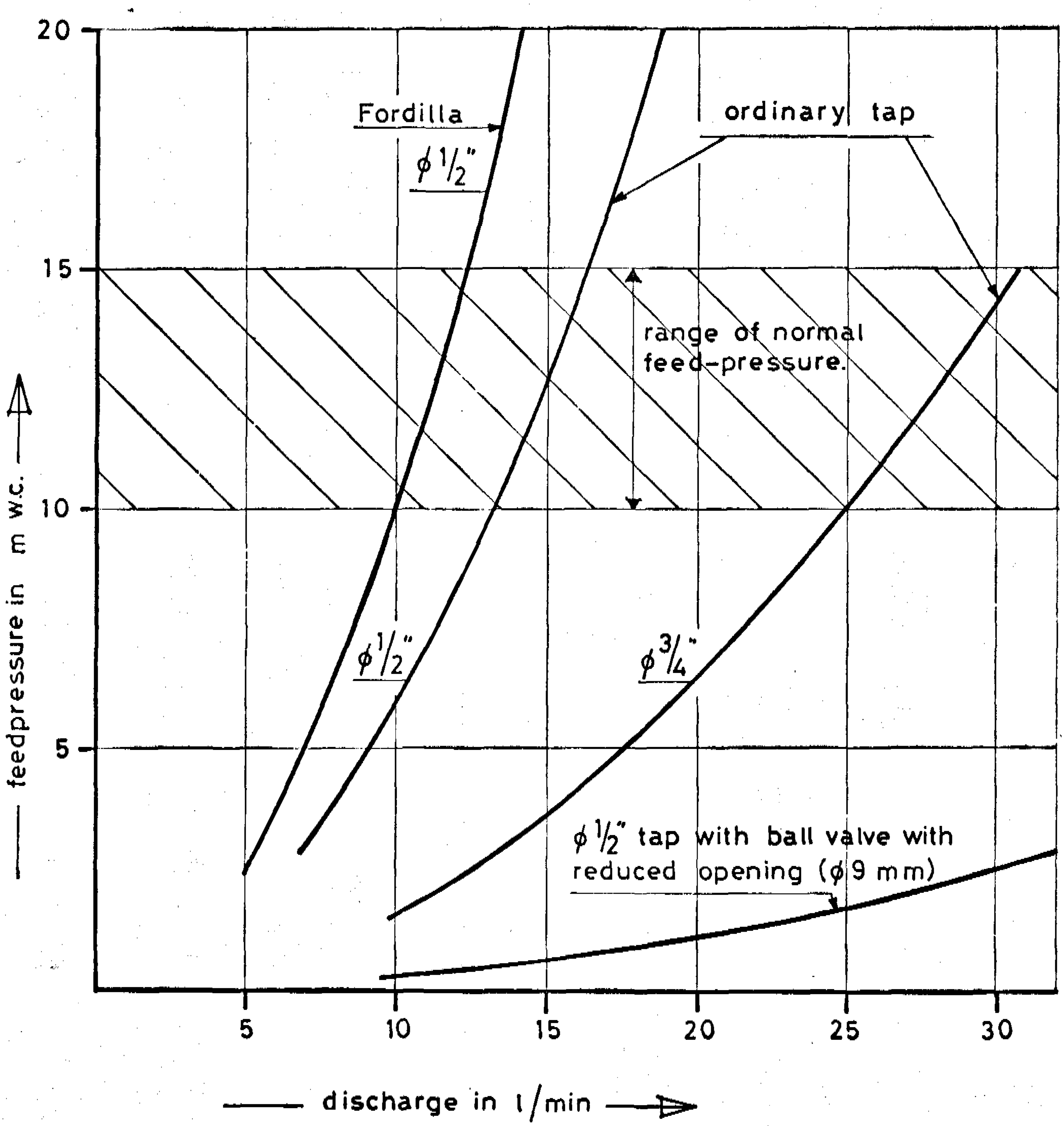
Seepage pit. Fig. 20



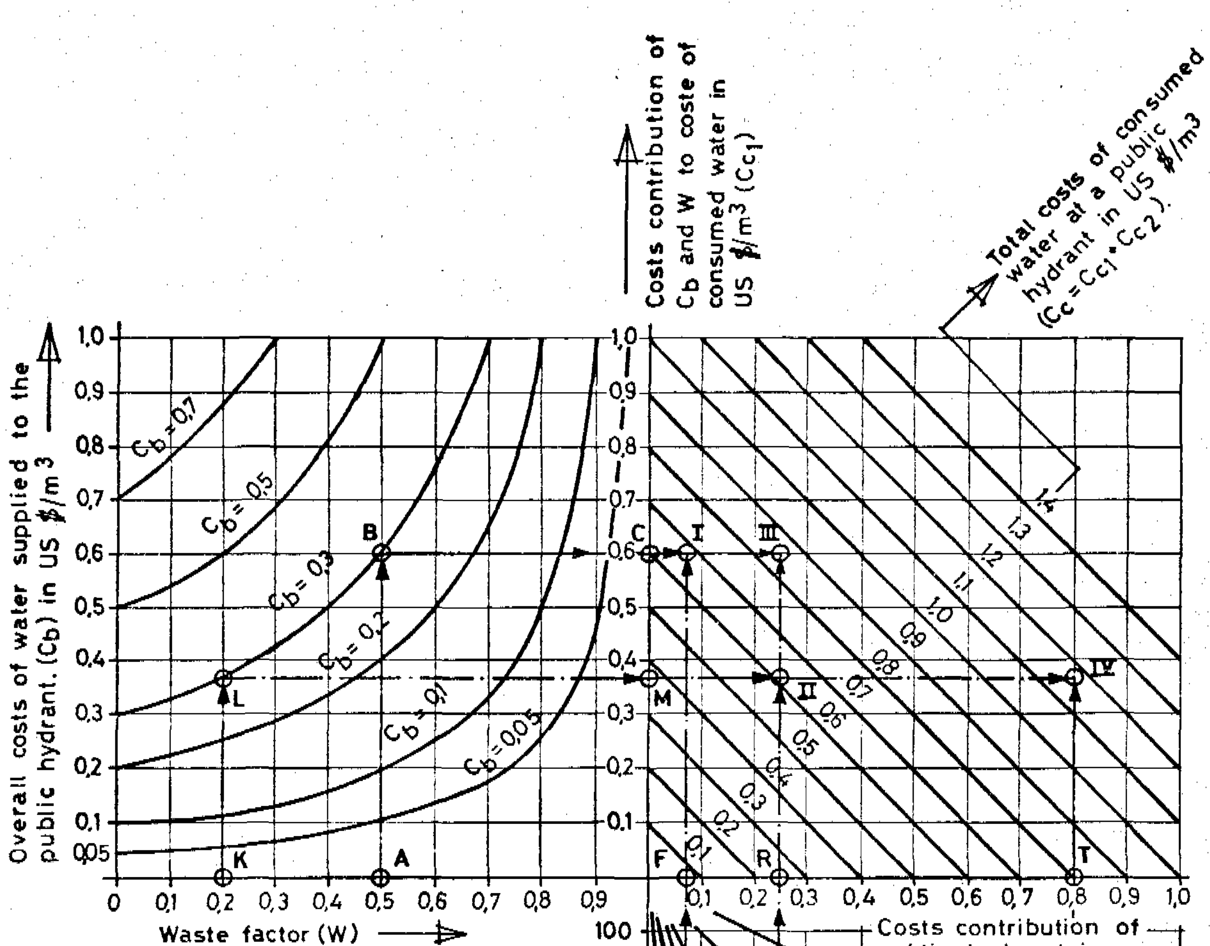
Soakage trench. Fig. 21

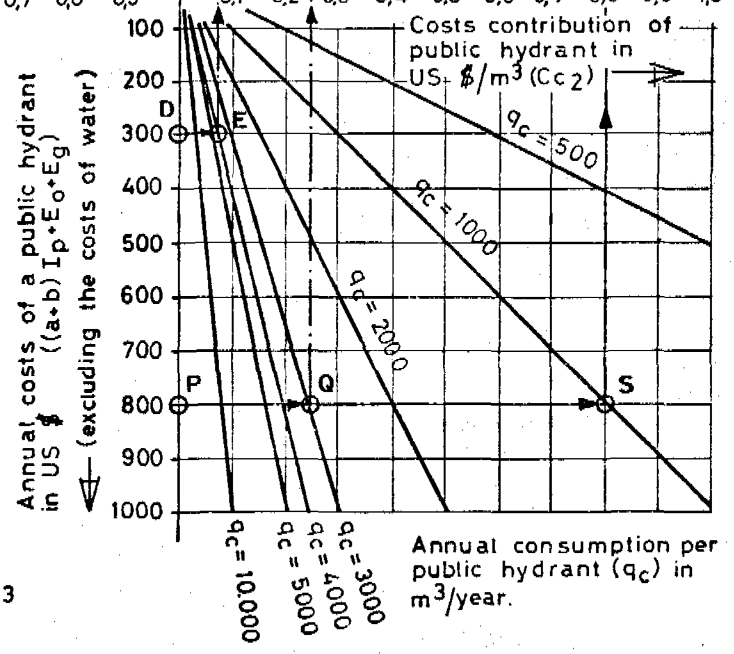


Waterkiosk. Fig. 22



Diagrams of discharge capacities of some types of taps. Fig. 23





- Total costs of consumed water at a public hydrant in US $/m^3:

$$C_c = C_{c1} + C_{c2} = \frac{1}{1-W} C_b + \frac{(a+b)I_p + E_o + E_g}{q_c}$$

- Costs of consumed water with regard to production and waste in US $/m^3

$$C_{c1} = \frac{1}{1-W} C_b$$

- Costs of public hydrant per m^3 consumed water in US $/m^3

$$C_{c2} = \frac{(a+b)\,I_p + E_o + E_g}{q_c}$$

Meaning of parameters:

C_c = Total costs of consumed water in US $/m^3
C_{c1} = Costs of consumed water with regard to production and waste in US $/m^3
C_{c2} = Costs of public hydrant in US $ per m^3 consumed water.
C_b = General production costs in US $/m^3
I_p = Capital investment of a public hydrant in US $
a = Factor for interest and depreciation.
b = Factor for maintenance and replacement.
E_o = Operation costs in US $ per year.
E_g = Annual costs of a guard in US $ per year.
q_c = Annual consumption per public hydrant in m^3/year.
W = Waste factor.

Graphic representation of the effect of the main elements on the costs of water used at the public hydrant Fig. 24