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Improvement of the Regulation Techniques in Turkey : The Example of the Harran Main Canal

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The main aim of the present communication is to show the choice of a regulation system adapted to the Harran Main Canal and to give a description of the operation of the storage reaches with mixed gates.

1 The Harran main canal and the classical regulation in Turkey

The Harran Main Canal is a 118 km long canal with a head flow of 80 m^3/s, it is a part of the Southeastern Anatolia Project (GAP).

There is no dead reach : intakes feeding the secondary networks are laid out along the whole of the alignment. It will be supplied from the Ataturk Dam reservoir by 2 parallel tunnels (Sanliurfa Tunnels), each 26.5 km on length and 6.5 m on diameter. The canal is designed to supply the irrigation networks in the Harran plain. Construction work started in 1988 and will continue through 1993. A total area of 141.000 ha is to be irrigated.

The regulation system had to be changed after the beginning of the construction. The system initially planned was an upstream type of regulation, which is classical in Turkey, but was checked not to be convenient because of the high risk of loosing water due to its very important size.

The present situation in Turkey for irrigation water conveyance is as follows :

- The present main canals are regulated from upstream in quite all the perimeters.

Constant upstream level regulators are fitted with gates and manual cross regulators to adjust the upstream level.

Intake discharges at the heads of secondary canals were to be regulated by double gating, but the initial principle is not applied owing to difficulties in using the system. As a result there is poor knowledge of the discharges taken off and wastage or temporary shortage of water.

- All the canals are operated by State Hydraulic Works personnel as far as the heads of watercourses (tertiary canals), after which the water is managed by groups of farmers, sometimes assisted by Land Administration.

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- The rotation system on the watercourse canal (tertiary canal) is not always used, and operator who does not possess an accurate schedule of water requirements for the coming weeks must allow a safety margin (extra discharge) to ensure that demand is met. This method of operation also leads to substantial loss of water.

- Until recent years, economising water was not a major preoccupation, but recent droughts together with problems of rising ground water and increased soil salinity result in lower farming yields and have made network operators and users aware of the problem.

It should be noted in particular, that because of last years drought, voluntary saving of water in the Lower Seyhan perimeter resulted in ٦ decrease of the consumption by 25 % while the agricultural yields increased greatly (by 20 %).

Economising water can be justified for other reasons in GAP projects :

- realising a complementary volume for the Ataturk hydro electrical power plant and for the dams downstream,

- reduction of drainage water volumes and hence economy of collection and treatment infrastructures.

2 Regulation solutions analysis

For the Harran Main Canal, the aim was to design and compare different regulation solutions in order to select the one best-suited to the following objectives :

- prevent water loss or temporary shortages in the face of uncertainties in water demand at the heads of the secondary networks,

- the present advanced state of the works on Harran canal (and the consequence : no change in the discharge sizing) is a constraint for the choice of the regulation for the main canal and even for the distribution network (size of the area/cropping pattern - changes allowed in upstream main structures),

- the necessity of a good acceptance of proposed operation techniques by the staff in charge of the operation of hydraulic structures.

Six different alternatives of regulation were studied :

0 Sol : Initial project : Upstream regulation

It is the basic project, designed by DSI. The main problem in that case deals with operation losses : if the distribution networks are operated as usual, it will be impossible to avoid important water losses, whatever the operating mode on the main canal, even by creating large regulation storage reservoirs. The water losses could rise up between 6 or 9 10^6 m^3 per year.

1 Sol : Downstream regulation

It is the most comfortable alternative as far as operation is concerned. It is unfortunately impossible to use on the whole canal because of the advanced state of the works in the upstream part.

Downstream regulation on the whole canal would certainly be the optimised alternative in case of a new scheme to be proposed.

Even if the Investment cost is a little high, the comfort in operation is the best : all downstream water demand variation problem is automatically solved by a very confident hydraulic localised regulation system.

2 Sol : Upstream regulation with remote monitoring of regulators and turnouts.

It is the minimum equipped feasible solution with upstream regulation. The remote monitoring allows a real time operation and using adapted real time calculations, the central operator can send (by phone or radio adapted orders to manage regulation on side reserves off the canal in order to minimise losses or temporary shortages in water supply to the perimeters. The regulation storage reservoirs are big because the lag time between the detection of a variation in demand and the adaptation of the supply law (discharge) is rather long (detection of the event, definition and transmission of the orders, action on the regulators ...).

Hydromechanical equipment is composed with constant upstream level gates except for the storage reservoirs which filling or emptying is controlled by motorised radial gates.

3 Sol :

It looks like 2 Sol except for the teleoperation system in which remote monitoring is replaced by remote control. All gates are motorised ones : the use of radial shapes is proposed as their operation needs lower energy compared with slide gates.

Electronics equipment foreseen here is the minimum necessary. In the design of the teletransmission equipment, it must be kept in mind that, in case of failure, the canal will have to be operated manually. But the manual operation of the two storage reservoirs would remain rather difficult to manage manually.

4 Sol : Upstream regulation - Storage reservoir on the canal

The setting of the canal is the same as in 3 Sol but the storage reservoirs are located on the canal. Their management becomes easier than in 3 Sol above all for manual operation in case of break down in the remote supervision system.

That solution is well adapted (as 5 Sol) for a 2 stages sharing works.

5 Sol : Mixed regulation

The canal is divided into three sections :

. the upstream one, from KP 0 to KP 56 equipped with automatic upstream constant level gates (like AMIL gates),

. the intermediate one, from KP 56 to KP 74, in which three mixed gates enable to create a storage capacity to ensure the good functioning of the downstream part and avoid losses,

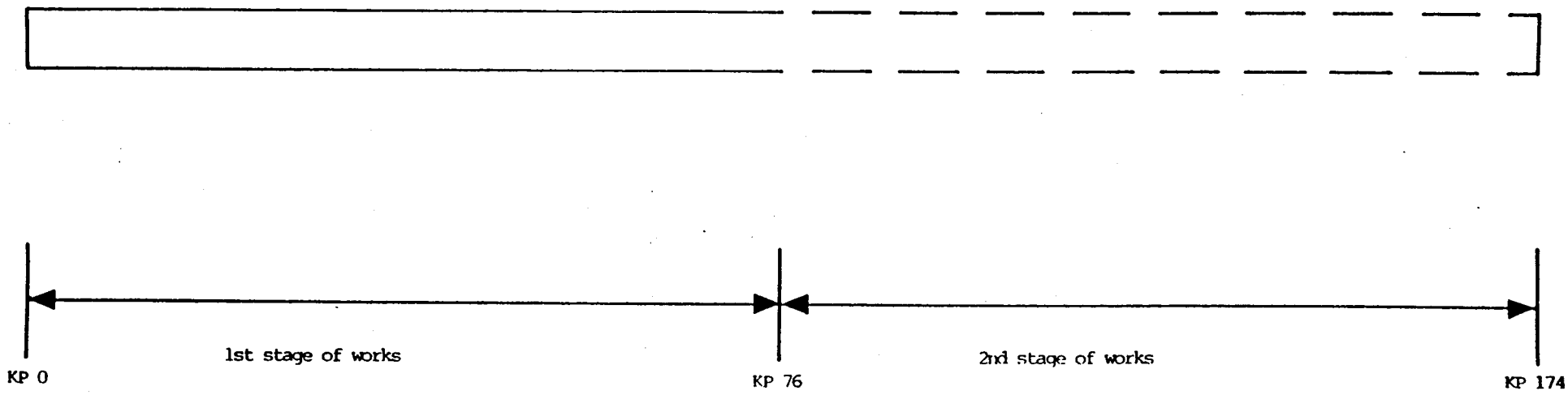
. the downstream zone, equipped with automatic downstream constant level gates.

This is the best suited alternative of regulation for the present situation, both for construction and operation reasons.

HARRAN CANAL

SOLUTION 0

UPSTREAM REGULATION



: Relay for radio transmission or instructions

: Secondary station for data collection (levels, discharges) and basic treatments

Operating Center : Treatment of datas coming from the secondary station. Elaboration of operating instructions for the HARRAN canal and the whole system (Tunnels, Mardin-Urfa canals)

Motorised gates

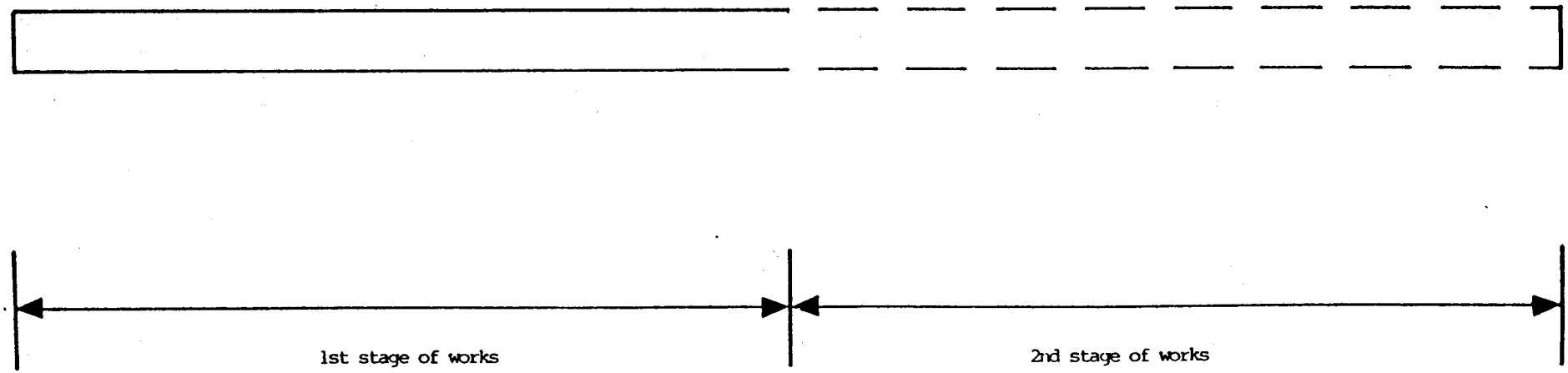
Mixed gates

Automatic downstream constant level gate

HARRAN CANAL

SOLUTION 1

DOWNSTREAM REGULATION



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Motorised gates

Mixed gates

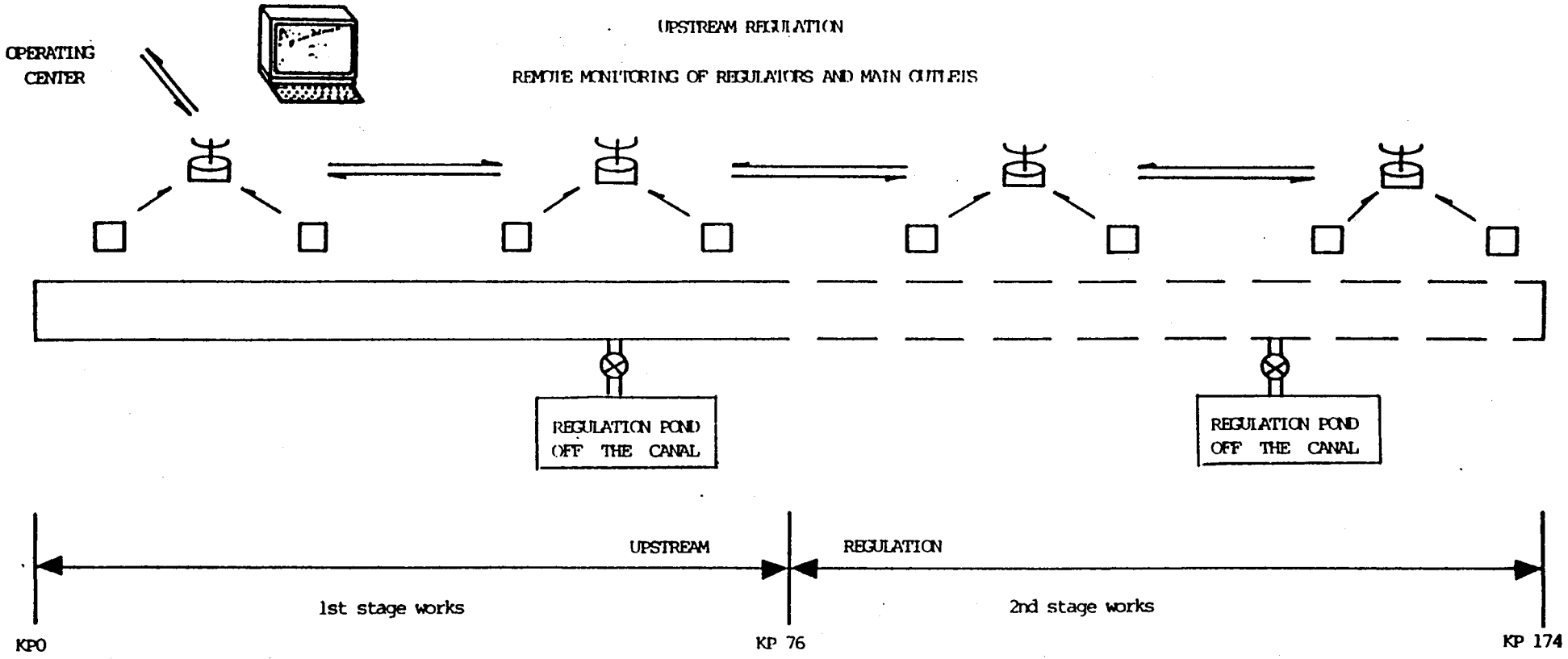
Automatic downstream constant level gate

HARRAN CANAL

SOLUTION 2

UPSTREAM REGULATION

REMOTE MONITORING OF REGULATORS AND MAIN OUTLETS



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Motorised gates

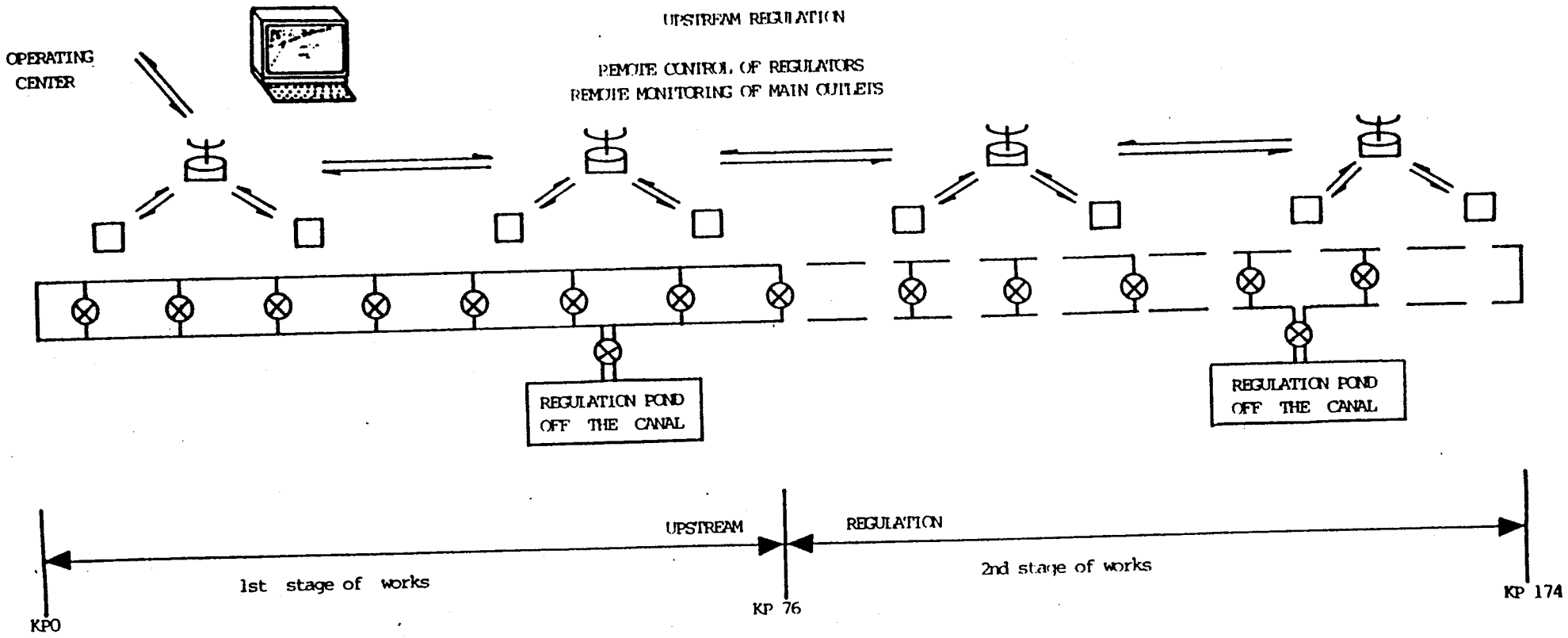
Mixed gates

Automatic downstream constant level gate

HARRAN CANAL

SOLUTION 3

UPSTREAM REGULATION



: Relay for radio transmission or instructions

: Secondary station for data collection (levels, discharges) and basic treatments

Operating Center : Treatment of datas coming from the secondary station. Elaboration of operating instructions for the HARRAN canal and the whole system (Tunnels, Mardin-Urfa canals)

Motorised gates

Mixed gates

Automatic downstream constant level gate

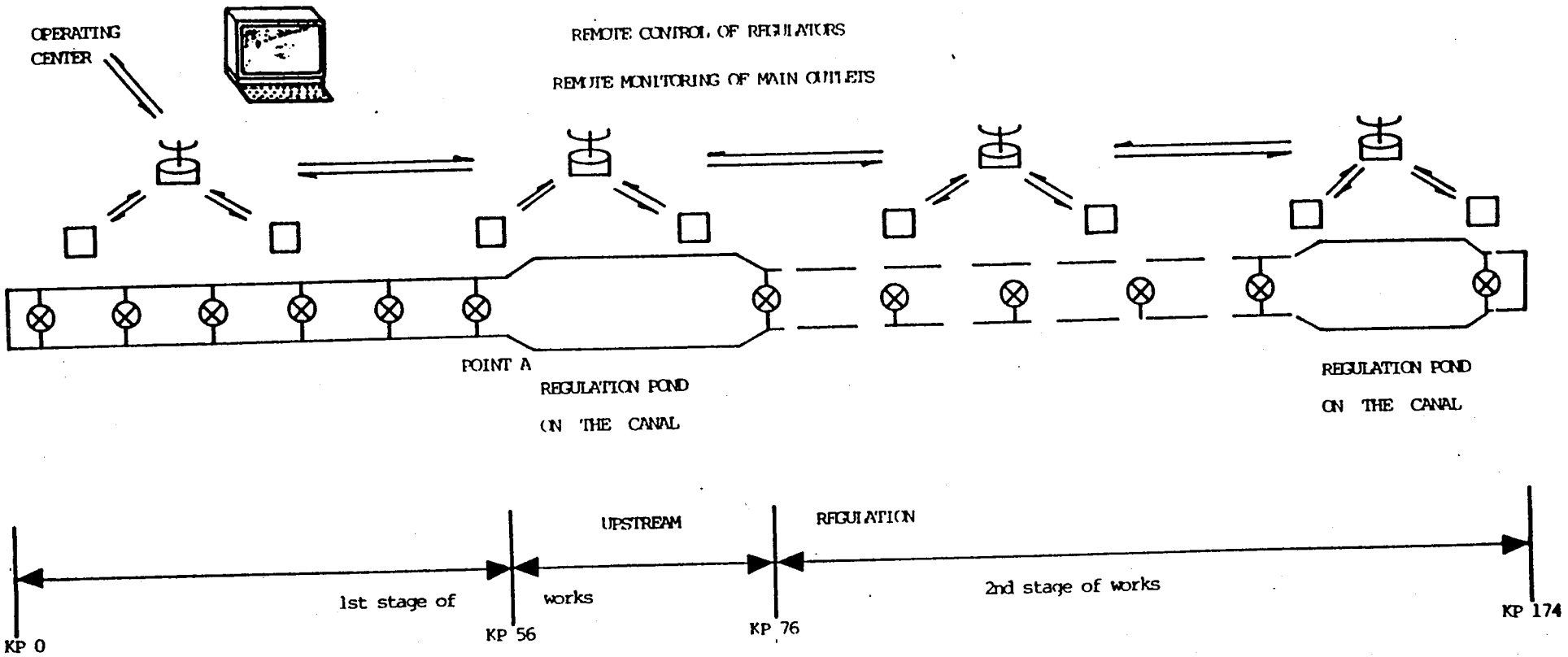
HARRAN CANAL

SOLUTION 4

UPSTREAM REGULATION

REMOTE CONTROL OF REGULATORS

REMOTE MONITORING OF MAIN OUTLETS



: Relay for radio transmission or instructions

: Secondary station for data collection (levels, discharges) and basic treatments

Operating Center : Treatment of datas coming from the secondary station. Elaboration of operating instructions for the HARRAN canal and the whole system (Tunnels, Mardin-Urfa canals)

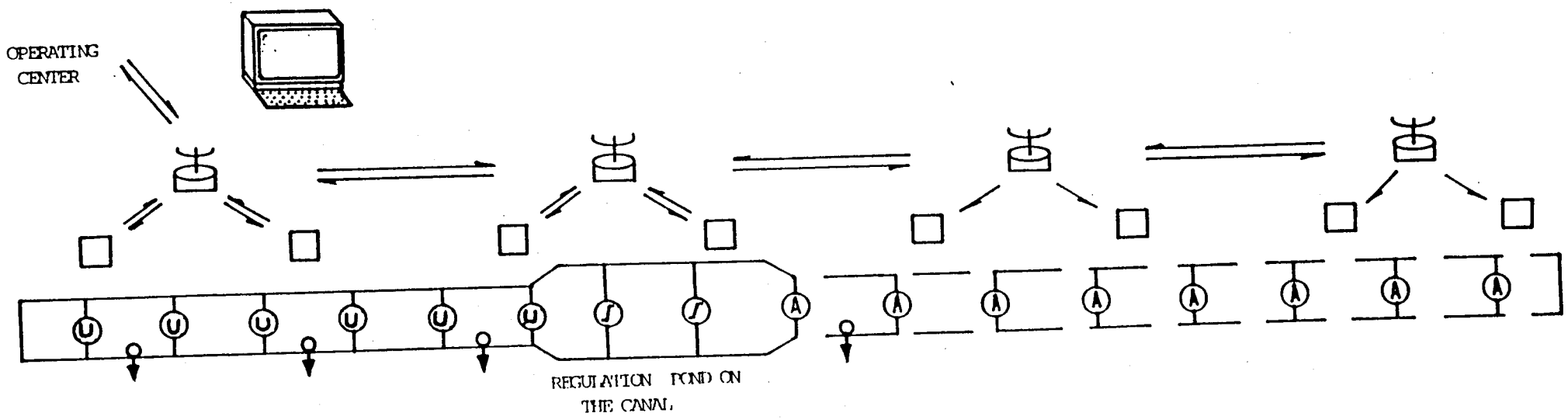
Motorised gates

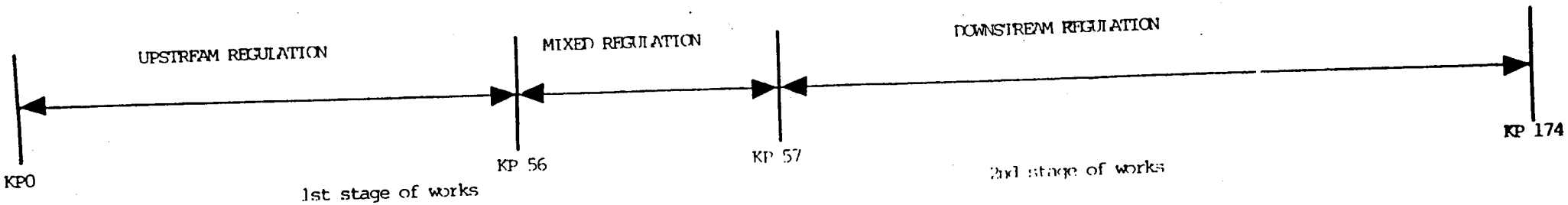
Mixed gates

Automatic downstream constant level gate

SOLUTION 5

MIXED REGULATION





: Relay for radio transmission or instructions

: Secondary station for data collection (levels, discharges) and basic treatments

Operating Center : Treatment of datas coming from the secondary station. Elaboration of operating instructions for the HARRAN canal and the whole system (Tunnels, Mardin-Urfa canals)

Motorised gates

Mixed gates

Automatic downstream constant level gate

AMIL gate

3 Comparison of the solutions

Solutions	0	1	2	3	4	5
Investment	100	142	142	136	130	122
Total cost	149	113	124	122	115	100

Solution 5 was selected as performing best in investment cost after the reference solution and as the least expensive of all the solutions in full costing.

This solution was also one of the best in terms of being able to accommodate the present state of the construction of the Canal.

It combines the three types of regulation (upstream, mixed and downstream controls).

A general remote supervision system is a part of the regulation system for the whole length of the canal, to obtain data at all times on the main hydraulic operating structures of the canal (discharge and water level at various points). The decisions required for head gate control operations can be taken immediately. The remote management is indispensable to achieve reliable and efficient water management and to avoid the losses which could be large from a canal which is to convey a large discharge (up to 80 m^3/s) for a great distance (120 km).

Canal management must also use computer facilities for calculation and flow modelling to anticipate hydraulic phenomena (water demand and the stopping of irrigation) as much as possible and above all to handle their consequences with regards to the amounts of water conveyed at all points along the canal.

This avoids the risk of loss of water.

4 Analysis of a reservoir reach

The phenomenon is only analysed for the reservoir section as the method of regulation of the other sections is known (upstream control and downstream control). The central reservoir section is divided into reaches separated by regulators (mixed gates) whose operating logic depends on neighbouring upstream and downstream levels. This logic is generally represented by the curve ABCDEF in the upstream-downstream diagram of the regulator.

AB- Functioning at minimum upstream level. Flow only occurs if the level in the upstream reach is greater than D1.

If D9 is considerably lower than D1, the downstream reach fills until the level reaches D1-h. Cycle BC starts here. If D9 is higher than (D1-h), regulation is of the constant slope type as soon as the downstream level is greater that D9.

BC- Constant slope.

CD- Combined levels (linear increase in the upstream/downstream loss of head).

The two functions above make it possible to make the neighbouring reaches play a reservoir role when the incoming flow is greater than the flows requested by irrigators downstream.

DE- Constant downstream level.

EF- Functioning with maximum upstream level (flood routing function) which makes it possible to use part of the freeboard to handle excess intake.

These regulators are most frequently hydraulically operated by water levels (combined level gates) but they can be controlled sector gates with local electronic regulation.

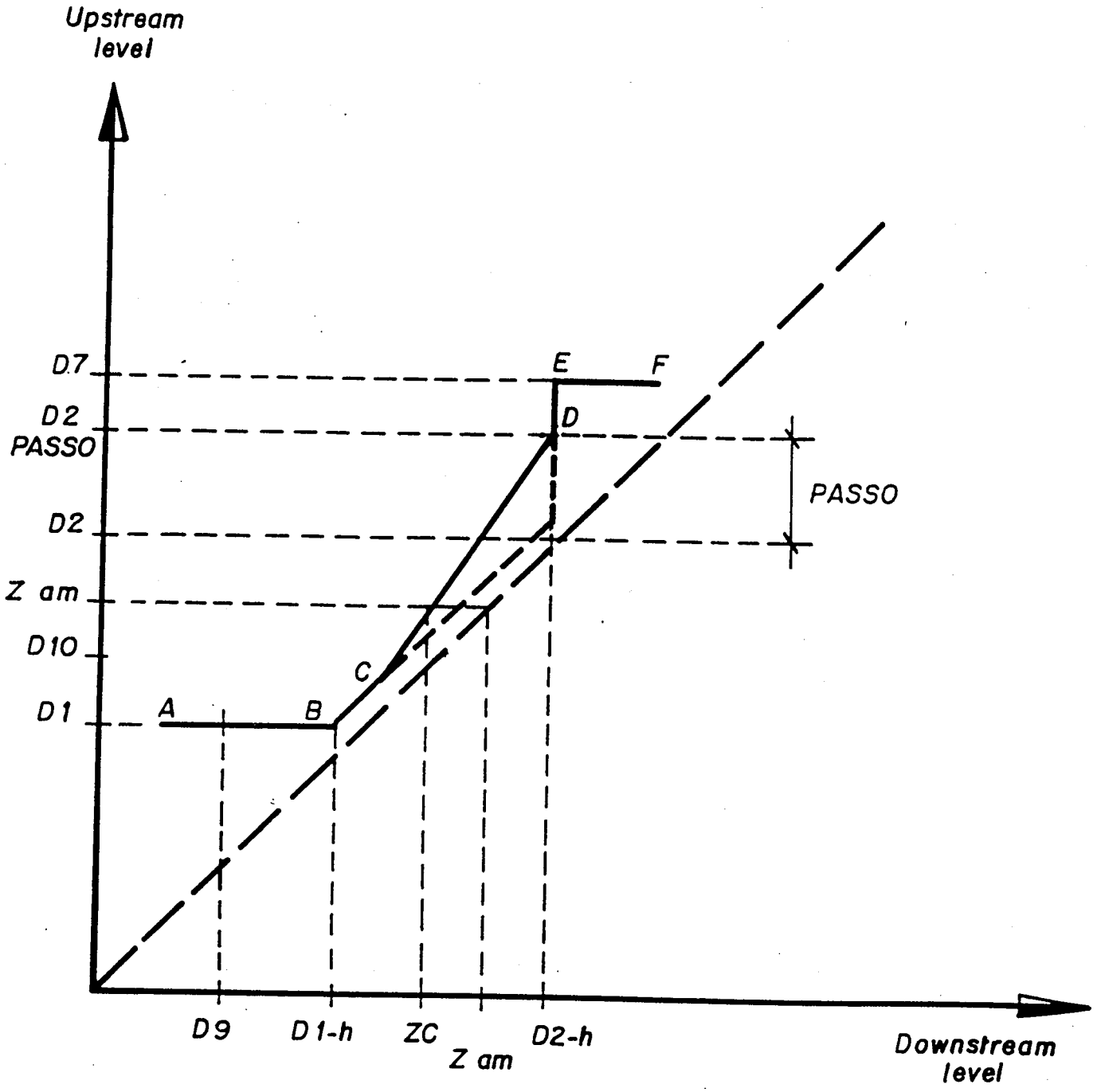
In case of hydraulically operated gates, they are fitted with an upstream float in a tank connected to the level in upstream reach and to downstream float connected to the levels in the downstream reach. The level combination law is obtained by a hydraulic relation using the various valves connecting the upstream reach, the upstream float tank and possibly an intermediate tank, the downstream float tank and the downstream reach.

Advantages of the system :

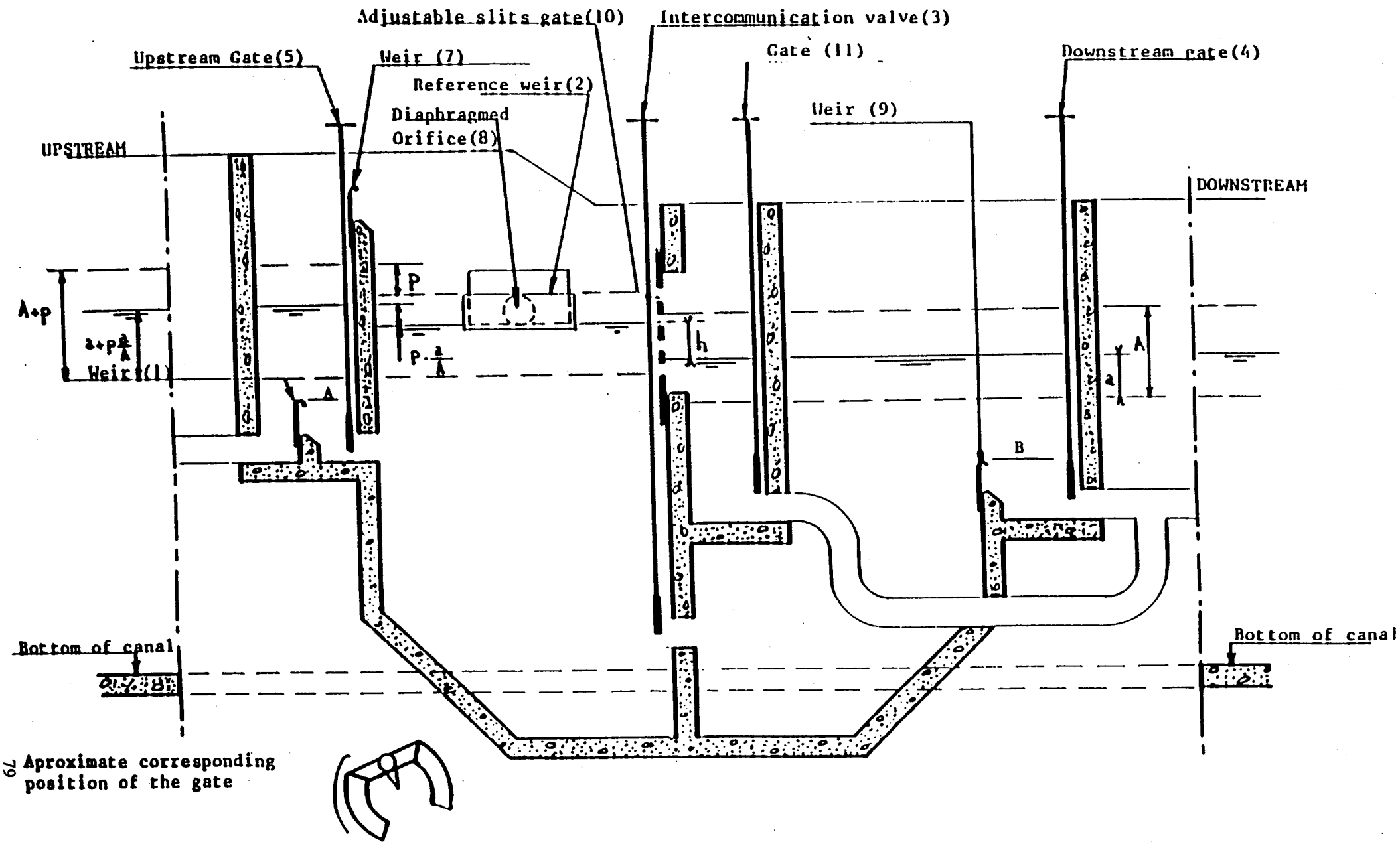
The combination of levels can convert several neighbouring reaches of the same canal into reservoir reaches ; regulation volumes can thus be spread over a considerable distance with lower civil engineering costs (marginal cost).

MIXED GATE

LEVELS ASSOCIATION LAW



SCHEMA VI


Adjustable slits gate(10)
Intercommunication valve(3)
Upstream Gate(5)
Weir (7)
Reference weir(2)
Gate (11)
Downstream gate(4)
Diaphragmed Orifice(8)
Weir (9)
UPSTREAM
DOWNSTREAM
A+P
a+P
Weir (1)
P
P.
h
A
a
B
Bottom of canal
Bottom of canal
Aproximate corresponding position of the gate