MECHANIZED IRRIGATION

by

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The mechanization of irrigation in our farming estates is calling for an urgent solution. Attention became focussed on this problem partly because of shortage in manpower, partly because of the trends in raising the technical level of agriculture.

The urge for mechanization is linked primarily with sprinkler equipment having mixed types of pipes or portable pipes. On national scale, the above-said irrigation equipment includes a pipe length of about 5100 km, to be moved repeatedly during the irrigation season. If pipe laterals are assumed to have lengths of 200 m on the average then this means 25,500 pipe laterals. Usually, one irrigation worker has to care for the moving of two laterals, resulting in a need for 12,750 irrigation workers. A single transfer of the pipes means the handling of about 17,000 metric tons.

Even disregarding future development, the data now displayed give ample justification for seeking an urgent solution of the problem.

1. Various kinds of mechanically transferred laterals

A review of the world's agriculture shows a number of ways of mechanizing the transfer of laterals. According to their basic principles these ways may be classified as:

a) pipes moved axially (or hauled laterals, for short),

b) pipes moved perpendicularly to their axis (or rolled laterals, for short),

c) rotating devices and

d) devices walking round.

The material of the above irrigation pipe laterals is usually aluminium, zinc-coated steel or non-deforming synthetics (polyethylene, polypropylene, etc.). In addition, there are so-called changeable laterals made either of non-deforming rubber or deformable synthetic fibre hoses.

In every case, equipment is moved from one position to the next by aid of an own engine or a separate one, without dismantling the laterals.

2. Investigations into the application of sprinkler equipment with mechanized transfer

When investigating the possibilities of application in Hungary, there are two points to be observed:

— equipment should be selected so that to find application in clusters already completed or for clusters with design in progress, based upon actually valid data. (Clusters are intermediate irrigation units between irrigation scheme and irrigated farms.)

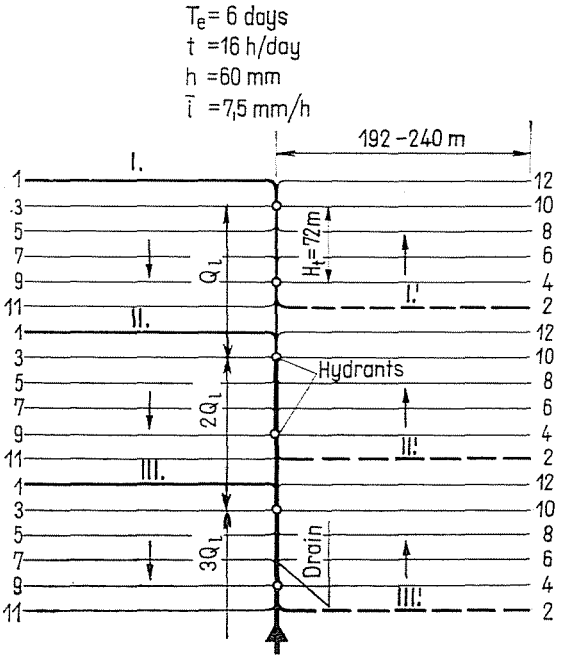

Fig. 1

— equipment should be found that suits best to Hungarian conditions, ensuring economic investment and operation for irrigated clusters to be designed and constructed later on, based upon data incidentally altered.

The laterals of clusters, either existing or designed in accordance with actual standards, are usually operated so as to yield a rain of $\bar{i} = 7.5$ mm or $\bar{i} = 10$ mm/hr intensity. Sprinklers are laid out in a 24×24 m mesh and there are 9 to 11 sprinklers operated simultaneously from one lateral. Thus, the length of laterals varies between 192 and 240 m. The distance between subsurface secondary pipes is 432, 480 or 528 m. Hydrants on the secondary pipes are 72 m apart and thus, laterals can be operated in six different positions from the same hydrant. The value of rain intensity has been chosen so as to enable the operation in 12 positions within a prescribed time, of the lateral

and its reserve, considering the standardized output of $h = 60$ mm of irrigation water (Fig. 1).

Thus, when operating mechanically hauled laterals, the above conditions have to be satisfied since it can be achieved this way only that along the secondary pipes of existing irrigated clusters or farms, the position of laterals should remain identical with the designed one (being 144 m apart).

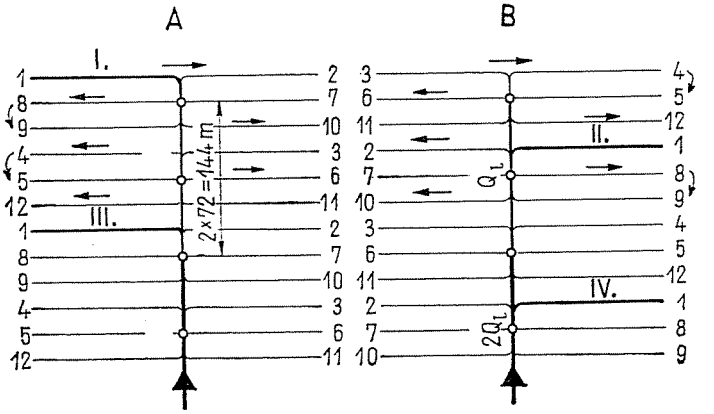

Fig. 2a

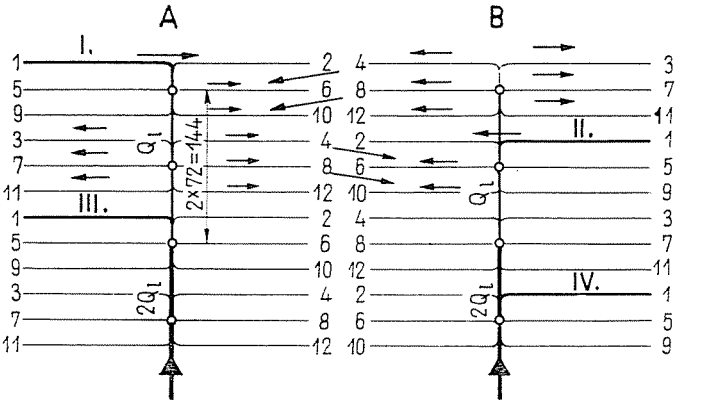

Fig. 2b

After having examined hauled laterals in accordance with the viewpoint mentioned above and also keeping the advantages of mechanical hauling in mind, one arrives to various alternatives of operating schedules. Fig. 2a shows an operation schedule with laterals used alternately along two secondary pipes. Lateral No. I is working first in positions 1 and 2 along the secondary pipe *A*, next it will be hauled to positions 3 and 4 along the secondary pipe *B*. Subsequently, the lateral must be dismantled, transported piece-by-piece and

assembled at position 5 and then hauled to position 6. Thus, lateral No. I must be dismantled and assembled twice when operated in 12 positions.

Lateral No. II is started from the outermost position of the second hydrant of the second secondary pipe and its direction of moving is opposite to that of No. I. Similarly to the latter one, it has to be dismantled and assembled twice, namely when moving from position 4 to 5 and then, from 8 to 9. Lateral No. III is moved exactly as No. I is, whilst No. IV moves in the same direction as No. II does. One may well see from the figure that this schedule is fully securing routine operation. (Routine operation is called the way of operation where a lateral is moving over every one position of the attached hydrant or hydrants.) The distance between designed positions of laterals is 144 m, identical to the value prescribed as a condition of departure. (Design positions of the laterals are shown on the figure by lines of various thicknesses.)

Fig. 2a shows an operational schedule satisfying the requirements stated above but laterals have to be dismantled after every fourth position before being transferred to the next one. The dismantling of hauled laterals, their transfer piece-by-piece and their assembling thus also requires manpower similarly to that of manually operated conventional laterals but only amounting to one fourth of the latter. It is thus desirable to seek for ways enabling the reduction or complete elimination of manpower.

The operation of laterals in Fig. 2b is also linked with two secondary pipes, and secures the required distance of 144 m between positions of the laterals and enables routine operation too. The operation schedule of the laterals, however, is differing from the one shown in Fig. 2a. Lateral No. I takes up operation at the secondary pipe A (positions 1 and 2) and continues with position 3 on pipe B. This time, however, it goes along the right side of the pipe instead of the left one, changing thus the sequence of positions 3 and 4 linked with pipe B. After having discharged the prescribed amount of rain in position 4, the lateral is hauled to position 5 on the left side of pipe A. When analyzing the schedule on this figure one perceives the complete elimination of dismantling and re-assembling the laterals at the expense of their being hauled semi-axially.

In Fig. 3a the operation of laterals is linked with three secondary pipes, resulting in a need for manpower after every sixth position only. Also, one may see that this schedule does not allow for a routine operation. The design distance between laterals is 72 m everywhere. The design discharges of 72 m reaches of the secondary pipes, however, are different, 72 m reaches of pipes A and C have to carry Q_l, $2Q_l$ and $3Q_l$, respectively, whilst similar reaches of pipe B are designed to carry $2Q_l$, $3Q_l$ and $5Q_l$ (Q_l denoting the discharge carried by one lateral).

When adopting the operation schedule of Fig. 3b, laterals are also here

linked with three secondary pipes. Although the distance between laterals of 144 m enables this schedule to be applied in existing irrigated clusters, the advantages of mechanical hauling were applicable to one third of the laterals only. Two thirds of the laterals had to be dismantled and re-assembled at transfer.

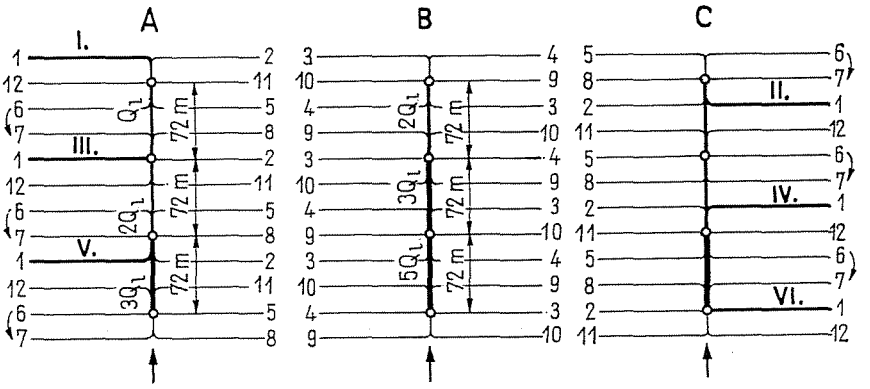

Fig. 3a

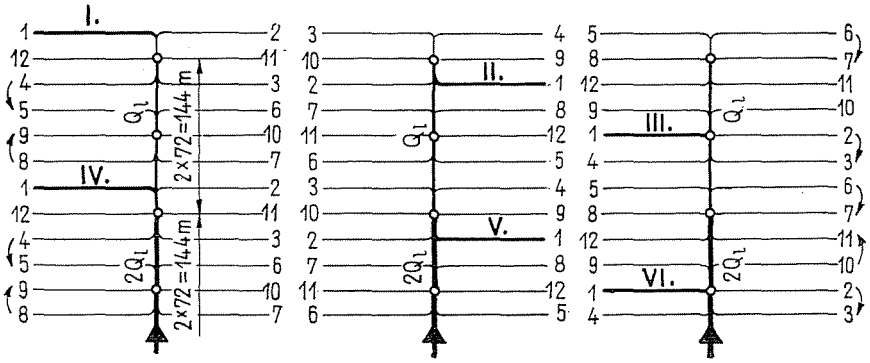

Fig. 3b

Fig. 4 shows a schedule with laterals linked with four secondary pipes. In both cases, the distance of 144 m can be secured between laterals but routine operation is not possible. Schedule 4a differs from 4b by the initial and final position of the laterals. The latter has the advantage of opposite laterals having the same initial or final position. The figure also demonstrates that after every eight position, laterals have to be dismantled and re-assembled when transferred.

By continuing the analysis of operational schedules involving the simultaneous use of 5.6 etc. secondary pipes one will find solutions similar to those described above. Details of these investigations, however, will be omitted.

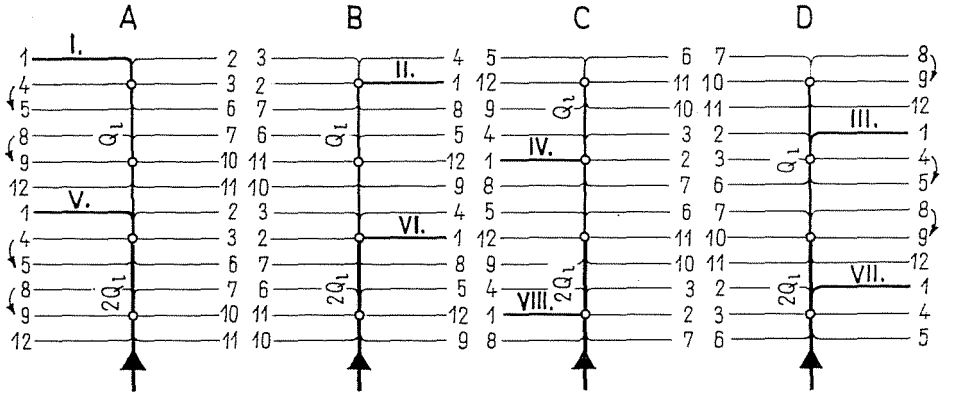

Fig. 4a

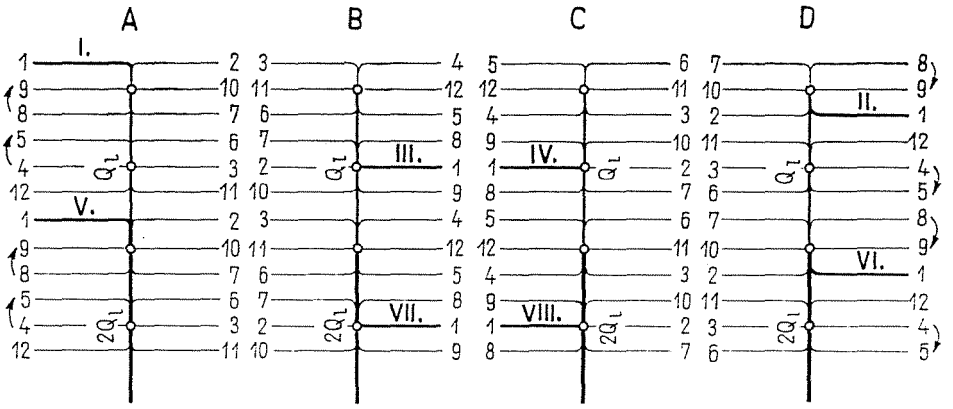

Fig. 4b

By summarizing our investigations into mechanically hauled laterals it can be stated that when using 2 to 6 secondary pipes simultaneously, an operation schedule is always to be found where the distances between lateral's positions are equal to a prescribed value. Among the displayed schedules, however, those shown on Fig. 2 are allowing only for a routine operation. Except schedule 3a all the other schedules may find application in existing irrigations if not contraindicated by crop-growing or other reasons.

Summary

The mechanical transfer of sprinkling laterals is one of the most urging problems of irrigation farming.

When investigating the mechanized transfer of sprinkling laterals in Hungary, two conditions should be kept in mind:

— adaptability of the methods to existing or actually planned irrigation equipment,
— design of laterals to be invested and operated economically with irrigation equipment to be designed in the future.

These conditions call for a wide-scope investigation. The present paper deals with the first point only, the research into operation schedule of hauled laterals. Results show that if the operation of laterals is coupled with 2 to 6 secondary pipes, there will be several schedules securing a prescribed distance between laterals, rendering thus these schedules applicable in actual operating irrigations. Routine operation, however, is made possible only when laterals are moving along two secondary pipes.

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