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#188

Surface Irrigation Can Be Automated

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THE WATER control facilities and management practices that farmers use significantly affect the amount of irrigation water used. Mechanized surface irrigation systems using automated control structures enable the farmer to apply water more efficiently and with a minimum of labor.

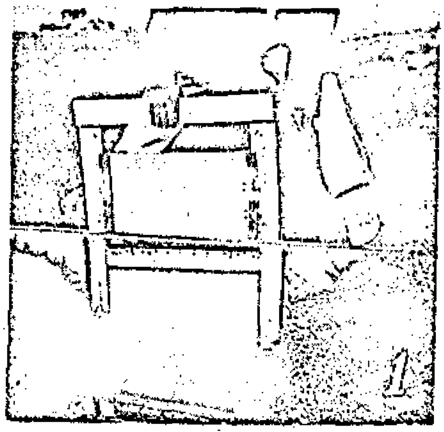
Ideally, these structures automatically stop irrigation on one portion of a field or farm and direct the water to another section as required.

For convenience, it is common practice in many areas to use either 12-hour or 24-hour irrigation sets. Often an irrigation of less than 12 hours, or between 12 hours and 24 hours, is sufficient to refill the root zone.

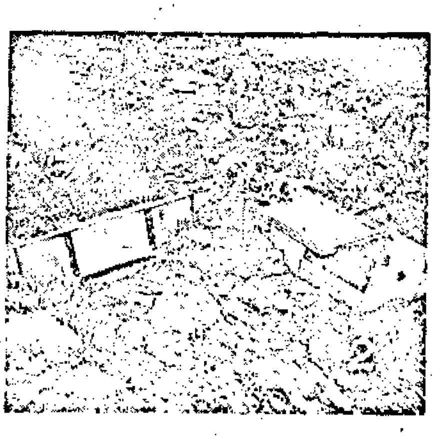
The available water supply then can result in a greater net return to the farmer, or serve a larger area, if water is changed from one set to another at the optimum time.

Some farms can use automatic structures with little modification of present systems. Several different kinds of structures developed at the USDA Agricultural Research Service Snake River Conservation Research Center near Kimberly, Idaho, and ways in which they can be used to mechanize or automate irrigation are described in this article.

One of these structures is a pressure gate (see figure 1. below). It has a horizontal pivotal axis or shaft located at about one-third the water depth at which the gate is intended to open. When the water level on the upstream side of the gate increases so that the water pressure above the axis is greater than that below, the gate opens automatically and remains open as long as water flows through it. It can be counterbalanced with a solid-metal weight located near the bottom of the gate or by a spring mounted on the backside. When water is turned from the ditch or when an upstream gate diverts water for another set, the gate automatically recloses. It is usually used with a companion structure such as the drop gate shown on the right in figure 2.



Automatic pressure gate mounted on a portable frame being installed in an existing structure.



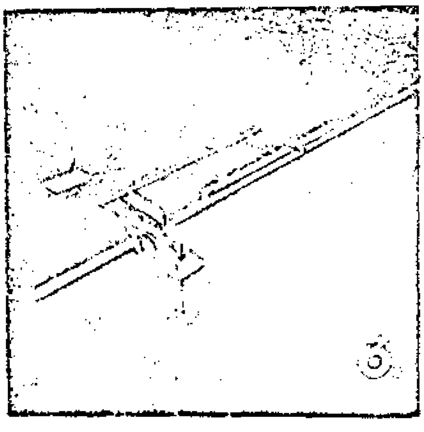
Rectangular, timer controlled drop gate (right) installed in unlined ditch with companion pressure gate.

A drop gate can be hinged at the top and suspended over the ditch in the open positions shown also in 2. It may also be suspended in a near vertical position, so that when it is released by an alarm clock, or by some other means, it falls by its own weight and stops the flow of water in the ditch or through the opening where it is placed.

This gate has been built in a number of configurations and has been used with alarm clocks on many farms to automatically divert water from one ditch to another or from a head ditch onto the field. When used as a companion structure to the pressure gate, the water depth in the ditch increases when the drop closes. This increase in water depth trips the pressure gate when the water level rises enough to force it open.

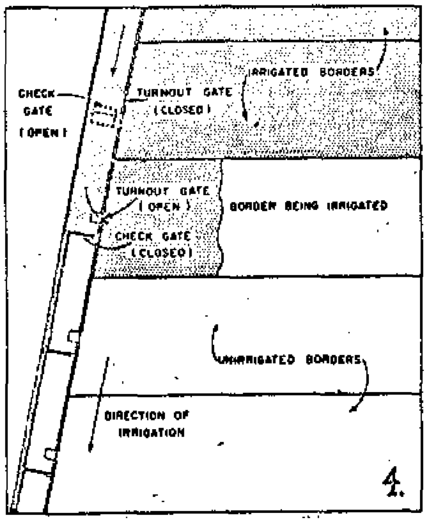
Both the pressure gate and the drop gate can be built for both lined and unlined ditches, and can be rectangular or trapezoidal. They can be permanently attached to a metal or concrete headwall or they can be mounted on a portable frame which in turn mounts in the checkboard guides or notches of existing structures.

Another structure that can be installed in an unlined ditch is the apron gate shown in figure 3. This gate is controlled by a timer or an alarm clock and consists of a sheet metal gate hinged at the bottom and mounted on a cutoff wall or headwall structure. When the gate latch is released by the clock, the gate opens and forms an apron in the bottom of the ditch below the headwall. It is used to release water sequentially from one turnout to the next in an irrigation head ditch.



Metal apron gate for an unlined ditch.

One way in which these structures can be used to automate a field is illustrated in figure 4. As shown here, irrigation proceeds from the upstream end of the ditch toward the downstream end. When irrigating in this manner, the pressure check gate is placed in the head ditch and the drop gate in the field turnout. The outlet into the field may be to a border, for that type of irrigation system; or to a spreader ditch or equalizing bay for a furrow irrigation system.



Schematic field drawing showing the arrangement of automatic gates for irrigating in the downstream direction.

When the scheduled irrigation is completed, the drop gate is tripped usually by a mechanical timer or alarm clock, and the flow of water into the field is stopped. This causes the water in the ditch to rise to the level required to trip the pressure gate. The water then continues down the ditch to the next pair of gates where the operation is repreated. Thus, irrigation proceeds in the downstream direction with each border or field segment irrigated in sequence.

Another method of irrigating the field automatically when the head ditch has considerable slope, uses apron gates (figure 3) in the head ditch with sills or checkboards in the field turnout structures. Existing checkboard structures can sometimes be used.

During irrigation, water in the ditch is checked by an apron gate and overflows the checkboard crest or sill. When irrigation is completed, the apron gate is tripped by a clock or other means and the water level drops below the sill or crest of the field turnout opening. The water then flows to the next set where the cycle is repeated and water overflows the checkboards of that turnout to irrigate the next portion of the field. The crest or top of the checkboards in the field turnouts are placed just high enough to prevent water from flowing onto the field while it is being conveyed to downstream turnouts.

Another way of using the structures is illustrated in figure 5 where irrigation proceeds upstream from the downstream end of the ditch. In this case, the drop gate is placed in the head ditch while the pressure gate is in the field turnout.

The field or border at the downstream end of the ditch is irrigated first. Water is checked consecutively at each upstream turnout by the drop gate. When the drop gate closes, the pressure gate in the field turnout opens and allows water to flow onto the field; thus, irrigation proceeds upstream.

Sometimes the head ditch will have enough slope so that a pressure gate in the field turnout is not required. In this case, water can be made to overflow a sill or crest onto the field in the same manner as described previously. The head ditch slope needs to be great enough so that the water does not back up from one opening into another, unless the irrigation stream is large enough to irrigate through more than one opening at a time.

One advantage of irrigating in the upstream direction is that in case of clock failrure, only one portion of the field is missed while the gate upstream normally operates as scheduled. If a malfunction should occur when irrigating in the downstream direction, water continues flowing on the same set until the problem is corrected.

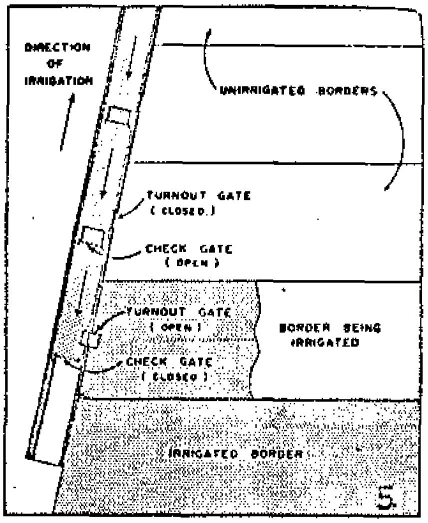
Another advantage of the system shown in figure 5 is that a pair of similar gates may be used to automatically divert water from the head ditch into another ditch leading to another field or portion of the farm when field irrigation is completed.

To do this with the system shown in figure 4, timing may be a problem. A timer at the diversion point would have to be set for the full time required to irrigate the entire field served by the head ditch, or else a 12-hour clock set sometime during the last 12 hours of the field irrigation. An electrical or hydraulic signal from the lower end of the ditch can sometimes be used to operate these diversion gates.

On the other hand, an advantage of the system shown in figure 4 is that water is free to pass through the head ditch between irrigations before the turnout gates are reset for the next irrigation. When not irrigating, the head ditch is sometimes needed to convey water to another portion of the farm or to carry runoff or excess flood waters.

Another advantage of this system is that the ditch is naturally drained after each irrigation, whereas, in the system shown in figure 5, the ditch is left partially filled with water. Also, leakage through the gates is used more effectively when irrigating in the downstream direction.

Surface flooding systems using basins, borders, or contour ditches are easier to automate than furrow systems because the field topography allows the entire stream to be distributed over the soil surface naturally. When furrows are used, the irrigation stream must be uniformly divided into many small streams directed into individual furrows. This requires furrow flow regulating devices or controls in addition to the check and turnout structures in the head ditch.



Schematic field drawing showing the arrangement of automatic gates for irrigating in the upstream direction.

One method of doing this is to place furrow tubes, either plain or gated, in a spreader ditch or equalizing bay parrallel and adjacent to the head ditch. When using equalizing bays, irrigation proceeds as illustrated in figures 4 and 5 except that water is diverted through the field turnout openings into the bays.

Although commonly used with sodded outlets, this auxiliary ditch has disadvantages and in many cases is not very practical. Some farmers have also used a group of small plastic pipes to convey from a manifold near the head ditch to individual furrows.

Another method of distributing water is shown in figure 6 using notched outlets in the side of a concrete-lined ditch. When notched openings or pipes in the head ditch are used, irrigation is accomplished by increasing the water depth until water flows through the openings or until the inlet ends of the pipes or tubes are covered.

Irrigation stops when the water level is lowered by the check gate releasing water into the next downstream portion of the ditch. The check gate can be a drawstring check as shown in figure 6 or an apron gate as shown in figure 3. When notched openings or slots are used in the top of a lined ditch, gravel may be necessary at each outlet to control erosion. When plastic furrow tubes or pipes are used, chemical weed control rather than burning is usually required to prevent damage to the plastic.

Experimental mechanical timers are being developed for use on irrigation structures but are not yet available commercially. A conventional alarm clock can be used for this purpose. (To lengthen its life, the clock enclosure should be sealed to prevent dust and water entry; this can be done by caulking the enclosure joints and by cementing a thin rubber sheet over the back of the

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Automatic irrigation with a drawstring check and notched furrow openings in a lined ditch.

clock to cover the openings; the rubber should fit tightly around the windup stems.) A conventional alarm clock can be set for a maximum of 12 hours; therefore, structures so equipped will require attention at least every 12 hours.

When irrigating as illustrated in figure 5, clock-controlled structures at the upstream end of the ditch need to be propped open for later setting of the clock when the total field irrigation downstream exceeds 12 hours.

Besides the water savings that may be realized from automatically changing irrigation sets according to the amount of water required to fill the root zone rather than according to a set time schedule, considerable labor can be saved. On farms where timer-controlled drop gates have been used to irrigate borders, labor was reduced from approximately 0.5 man hour per irrigation to 0.028 man hour per irrigation. In other words, irrigating with clock-controlled structures required only about one-seventeenth as much labor as normal irrigation.

Certain operational problems, however, are more important and require greater emphasis with automatic irrigation.

For instance, greater attention must be given to rodent control to avoid ditch washouts.

Ditches must also be kept clean and weed free to prevent overtopping when an irrigator is not present and to maintain constant water levels in the ditch.

Automatic structures that are controlled by the depth of water, such as the pressure gate, are affected by unpredicted variations in water level caused by weedy or partially clogged ditches. Overgrown weeds themselves also may interfere with the structure's normal operation.

Sediment should be removed from the water or its entry prevented to eliminate the need for frequent ditch cleaning. Screening devices may be necessary to eliminate trash and floating moss, and to minimize the weed problem. Tillage practices may have to be altered to some extent, particularly with row crops.

Unequal tractor wheel or other farm machinery traffic often changes the intake rate from one furrow to another. These intake rate variations require different stream sizes and are difficult to compensate for in an automatic system.

Greater attention must also be given to field layout. Irregular and odd-shaped fields need to be minimized so that a uniform length-of-run can be obtained for all sets in a given field.

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