AUTOMATIC WATER CONTROL STRUCTURES FOR SURFACE IRRIGATION [1/]

by

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Many improvements have been made in irrigation methods and equipment in recent years. However, surface irrigation has not benefited from automation and still requires much hand labor. In addition to this high labor requirement, an excessive amount of water is often used. This is particularly true in areas where water is relatively cheap and labor is scarce. Further improvement in surface irrigation methods and equipment using mechanized, automated control structures will enable the farmer to apply water with a minimum of labor and to obtain maximum use from the water thus conserving the resources

Improved automatic methods and devices must provide more than mere novelty or convenience. They must be practical, dependable, versatile, and economical. A structure must be simple and easy to construct and to use. Various kinds of automatic control structures are needed to satisfy the requirements of different types of irrigation

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systems as dictated by soil, topography, cropping and weather conditions. They are needed for both lined and unlined ditches. Some systems require portable equipment; others require permanent and semipermanent structures.

Automatic irrigation structures may vary from simple alarm-clock-controlled check dams to elaborate radio-controlled structures employing moisture-sensing devices or programmed timers. Regardless of the complexity or means of control, the general operation is similar. Automatic checks or gates, placed at proper intervals in the distribution ditch, check the water and divert it onto the field through border turnouts, spiles, sodded outlets or other means. After a predetermined time, each check or dam is automatically released and the water allowed to flow to the next structure. Thus, the field is irrigated in sequence, a portion at a time. Electrically operated control structures may be used to divert water from one field to another.

Because of the need for various kinds of automatic irrigation structures, a part of the program at the Snake River Conservation Research Center is aimed at developing equipment which will fit most irrigation schemes. Most of the work thus far has been confined to the laboratory, where various models have been built and tested in a recirculating flume. One such model is shown in Figures 1 and 2. This semiautomatic check consists of a butyl rubber dam supported in a metal frame which is designed to fit the cross section of a lined ditch. In the closed position, the top edge of the rubber dam is supported by a nylon drawstring threaded through brass grommets. The drawstring is released by a timer after the desired irrigation time period has elapsed. This unit is simply constructed, lightweight and portable. It may be easily picked up and placed at a location in any ditch of the same cross-sectional shape. It is constructed with a timer release device which permits the check to be reset anytime between irrigations. The timer is released by a float and begins timing the irrigation period when water enters the ditch immediately upstream from the check.

Two variations of the above model are also being tested for use in unlined earth ditches. With one of these, the butyl rubber dam is mounted on a metal bulkhead or cutoff wall (similar to that shown in Figure 5). This is a semipermanent type in which the opening conforms approximately to the size and shape of the ditch. The ends of the cutoff wall extend into the sides and bottom of the ditch to prevent piping. This type would usually remain in place for at least one or two seasons after which it could be relocated if desired. The second variation is a portable type which is used in the same manner as the conventional canvas irrigation dam. The general operation of these two is the same as that of the lined ditch model.

Another structure for use in lined ditches is shown in Figure 3. Variations of this gate are being tested for both lined and unlined ditches. In the open position, the gate is suspended from the upper frame by a latch and water passes beneath. When released by a timer or electric solenoid, the gate drops into the closed position and checks the water in front of it. This model is particularly useful where water is diverted from one distribution ditch to another. When used as part of an automatic headgate structure, it is tripped electrically by a signal from the lower end of the ditch. An opening may be provided to bypass part of the flow, as shown in Figure 3.

Figures 4 and 5 show a semipermanent structure for use in unlined ditches. This model consists of a butyl rubber tube connected to the opening in a cutoff wall installed in the ditch at right angles to the flow. The gate opening is closed by hanging the unattached end of the tube from two hooks near the top of the gate. The tube is released by a timer mounted on the bulkhead.

These structures may all be adapted to fit systems using different methods of irrigation. They may be used in systems employing moisture-sensing devices, programmed timers, or radio- and float-controlled equipment. A recent development in furrow irrigation systems is the use of automatic cutback or reduced furrow flow. In this system, the initial furrow stream is reduced or cut back in size after water reaches the end of the furrow. The furrow intake rate usually decreases rapidly with time during irrigation. With a lower intake rate, a smaller stream size may be used, resulting in decreased runoff and increased irrigation efficiency. The check shown in Figures 1 and 2 is well suited for this type of system.

Various experimental models, including those referred to above, will be field tested during the next two summers. From these tests, data pertaining to installation, operation and labor requirements, and water savings will be obtained. The per acre cost of an automatic system will vary with the method of irrigation, soil, topography, cropping practice, water supply, and other factors. The unit cost of the structures manufactured commercially will be considerably less than the experimental models and is expected to be economically feasible.

LIST OF FIGURES

Figure 1

Automatic butyl rubber check for lined ditches in the closed or reset position.

Figure 2

Drawstring check shown in Figure 1 in the open or released position.

Figure 3

Experimental model of an automatic metal check gate for by-passing a portion of the stream or for diverting water from one field ditch to another.

Figure 4

Experimental model of a butyl rubber tube semipermanent structure mounted on a cutoff wall for installation in an unlined ditch.

Figure 5

Rear view of the structure shown in Figure 4 in the open position. In the closed position, the free end of the butyl tube hangs from the hooks which may be seen near the top of the structure.

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Irrigation without irritation

Automatic watering can save you time,

Engineers now foresee the day when irrigating several hundred acres will be as easy as watering your lawn. Computers will buzz and whir into action, activating automatic irrigation systems after reviewing data on climate, soil conditions, and cropping practices. Until then, farmers will have to settle for lesser, though still spectacular, feats of irrigation research and design.

In fact, several automatic systems that can save time, water, and money already are headed for the farm. A system developed by the Irrigation Research Station, Altus, Okla., is just one example. It is a practical, automatic method of cutback furrow irrigation.

Furrow irrigation often wastes water. Soil intake rates, farmers know, fall off rapidly during irrigation. Unless stream size is cut back after water first hits the end of the furrow, following water trickles away as runoff. So reducing flow by cutback furrow irrigation saves water. Unless automated, however, this method pushes labor costs higher than farmers like to see them.

Oklahoma's answer to this problem is a concrete-lined ditch built as a series of level steps or bays (see photos). Level furrow-outlet tubes go into the concrete at the time of construction. Gates go between bays.

When turned into the ditch, water climbs in the first and highest bay until each tube discharges the initial furrow flow. When water reaches the ends of furrows irrigated by this bay, the check dam at the end of the first bay is removed. Water then rises in the next lower bay until tubes in this bay discharge the initial furrow flow. Water drops in the first bay so the head of water is enough only for reduced, cut-back flow into the furrows.

When water reaches the ends of furrows irrigated by the second bay, the check dam at the end of this bay is removed. The third bay now irrigates with full initial flow, the second bay irrigates with cut-back flow, and the first bay doesn't flow because the water level is below furrow outlets.

This method may not fit all irrigation conditions, but it is well adapted to conditions where the supply flow for the ditch can be maintained at all times. Engineers must know initial and final furrow flows plus supply flow before the system is designed; it will take the planning of an expert to set up on your farm.

What about cost? James E. Garton, one of the system's designers, reports a contractor's estimate that installing the outlet tubes when the ditch is lined would add about 50 cents per foot to the cost of concrete-lined ditches.

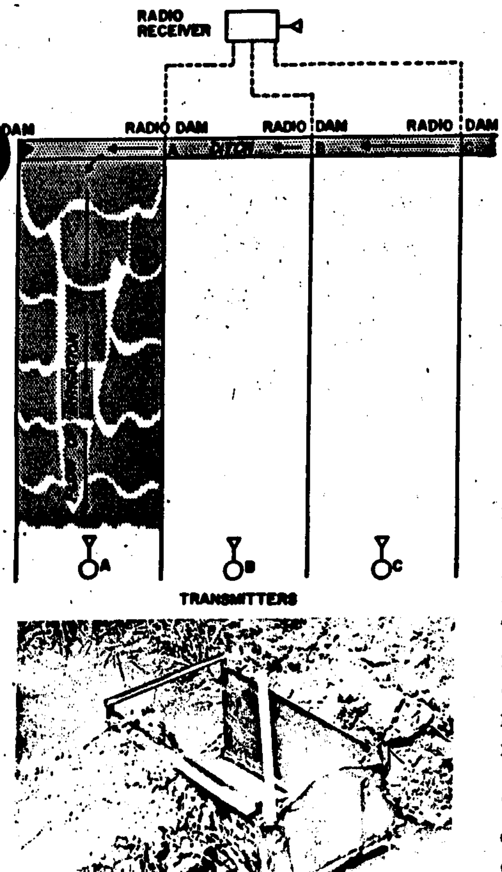
Automatic or manual gates can be used in the system. The automatic gate set would include a timer, solenoid-operated latches, and mechanized gates. This would cost another $20 to $25 per acre.

It may sound like a big investment. But Garton and other developers have found —even with manually operated gates— that they can put three inches of water on 15 acres with less than 15 minutes of labor. It would take more than 22 hours of labor to irrigate the same-sized field with a conventional siphon-tube system and one man in constant attention. And automated irrigation increases management flexibility.

"When considering cost, you shouldn't overlook the consideration that after switching to an automatic system the decision on whether to irrigate or how often to irrigate is no longer based on the availability of labor," says Garton, an agricultural engineer at Oklahoma State University. "Also, farmers might expect higher yields from more timely irrigations."

Engineers have not ignored border-dike watering in their efforts to mechanize irrigation. For instance, Charles C. Bowman, head of agricultural engineering at Montana State University leads a team developing an exciting setup for automatic border watering.

The Montana system is a series of radio-controlled dams and turnouts which gets power from a 12-volt car battery. A transmitter goes at the low end of the border (see diagram). As the border floods and water reaches the transmitter, moisture contacts a sensing device. The transmitter beams a signal to the receiver, which closes the dam to the first border and



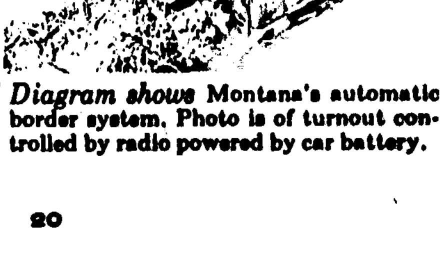


Diagram shows Montana's automatic border system. Photo is of turnout controlled by radio powered by car battery.

By George Sollenberger

money and water

opens the turnout to the second border.

Researchers also are studying receivers with more channels, which would allow irrigation of many borders without changes in automatic settings. Designers may build a monitor that would let farmers check the whole system from truck or-home.

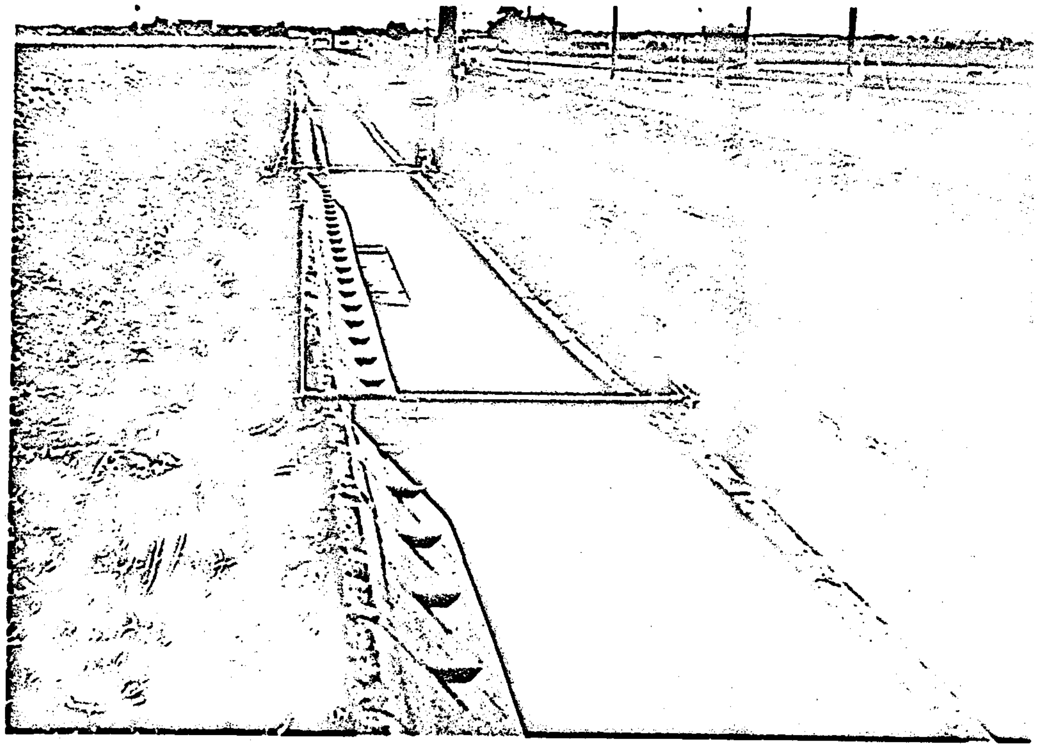
Bowman says the Montana system should boost application efficiency, make better use of available water, and ease drainage problems. The setup is now designed to irrigate runs up to half a mile long, but this could be stretched with more-powerful transmitters.

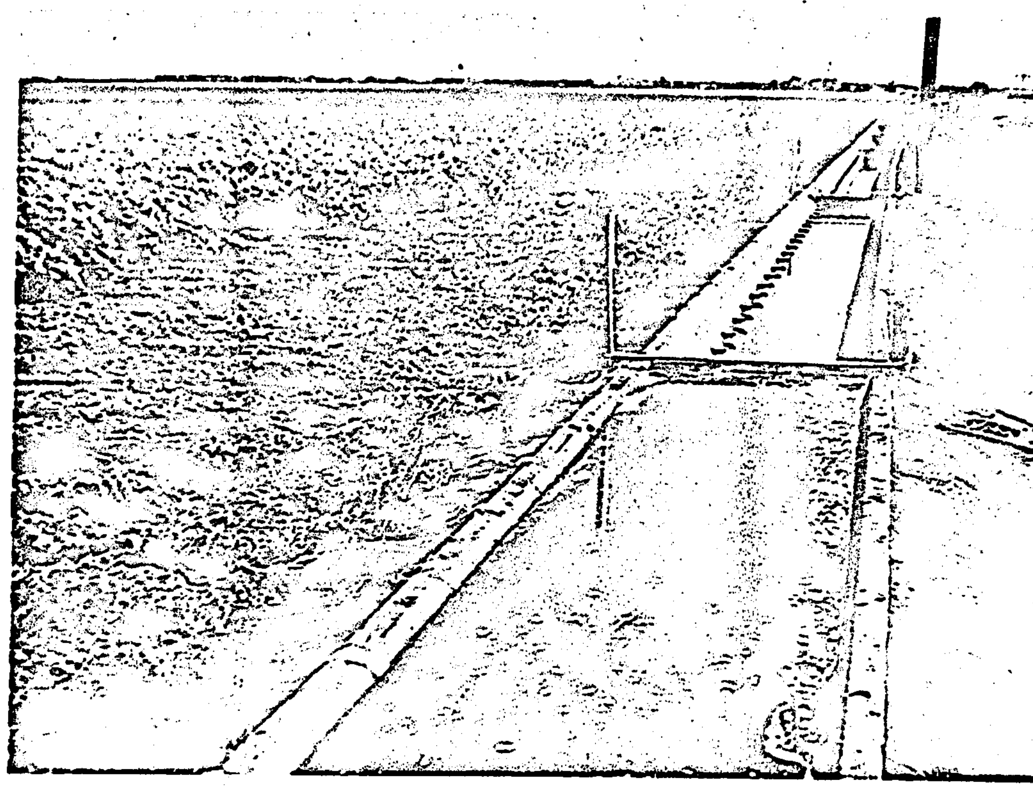
Cost figures now available are only [illegible]h estimates. But these place the cost [illegible]e set at about $275 when mass pro[illegible]d. That would buy two transmitters, one two-channel receiver, two metal dams, and two turnouts. The equipment, however, is light and could be moved from one border system to another.

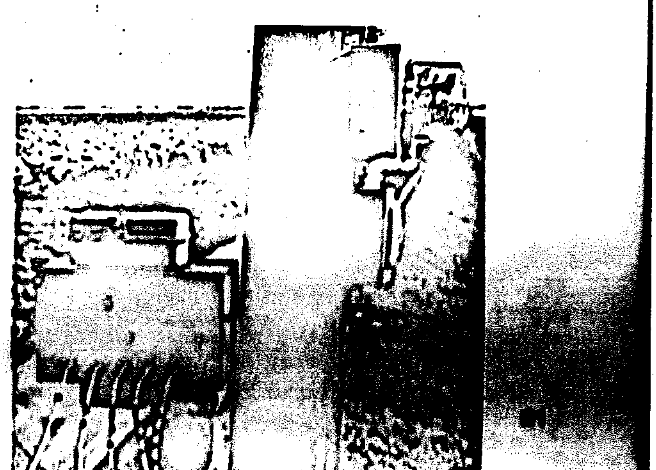
Personnel at the Snake River Conservation Research Center, Kimberly, Idaho, have designed a semi-automatic check dam which also features portability. The check consists of a butyl-rubber dam supported in a metal frame, which is designed to fit the cross-section of a lined ditch. When closed, the top edge of the rubber dam is supported by a nylon drawstring threaded through brass grommets.

A timer releases the dam and water flows on to the next irrigation set. The checks are simply constructed, light, and may be moved to any same-sized ditch. Engineers are working on similar units for unlined ditches.

There are, of course, many more new developments in the field of automated irrigation. If you're shopping for labor savers, contact your state agricultural c[illegible]e for information on a system for [illegible]rm. But remember that manage[illegible]ovided by the farmer is still more important than physical facilities.







Three photos **show system of automatic cut-back furrow irrigation. Top picture reveals construction of level steps or bays with furrow outlet tubes built into concrete. Middle photo shows system in use, with one bay discharging initial furrow flow, the next discharging cut-back flow. The bottom photo is of automatic timer which opens mechanized gates between bays. System could shave labor costs thousands of dollars yearly.**