CONTRIBUTING EDITOR

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Automatic furrow irrigation systems

Many attempts have been made to simplify irrigation and to reduce irrigating labor. The success of center pivot and other mechanized sprinkler systems in meeting these objectives largely accounts for their popularity today. As energy and labor costs increase, many irrigators are looking for ways to cut operating expenses by increasing irrigation efficiency and lessening labor needs.

Although sprinkler irrigation has grown tremendously in recent years, about two-thirds of the irrigated acreage in the United States is still surface irrigated. According to the latest available agricultural census and irrigation survey data, about 24 million acres, or 41.6% of the total irrigated acreage in the U.S., is furrow irrigated. Of that, 22 million acres, or 44%, are in the 17 western states. In addition, another 14.4 million acres are irrigated by flooding methods.

Because surface irrigation uses less energy than sprinkler systems, increased emphasis is being placed on automating surface systems. Automating these systems, particularly furrow systems, is not easy, which is why so few automated systems are in use. Labor requirements for conventional furrow irrigation systems using siphon tubes and open ditches range from about 20 to 45 minutes per acre per irrigation, depending on the length of run, the condition of the ditch, and whether the siphon tubes remain in place or are moved from one set to another.

Labor can be reduced to about 12 minutes per acre per irrigation if manually operated gated pipe is used and to 6 minutes if the system is automated. By comparison, the average labor requirement for center pivot systems is about the same as that for automated gated pipe furrow systems. The irrigation efficiency of the two systems is also about the same if a reuse system is used with the gated pipe.

The initial cost of an automated surface system is usually less than that of sprinklers, particularly if water is supplied from a canal. Both systems have limitations as to where they can be used, and each should be used where it is best suited. Key factors to consider in choosing between the two systems are the escalating cost and the reduced availability of energy. Electrical costs in some parts of the country are projected to double in 5 years and triple in 10 years.

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DIESEL:		500 HRS	1000 HRS	1500 HRS
ENGINE CAT	3208-210			
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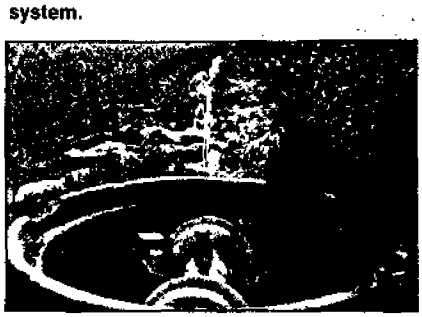
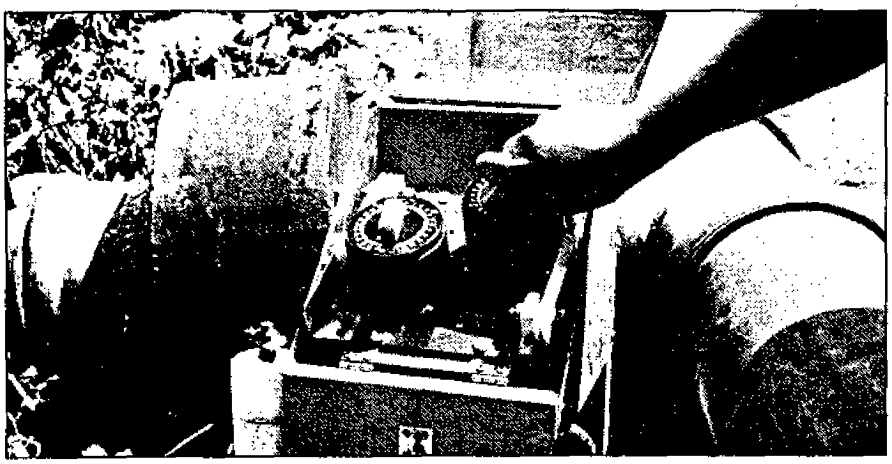
COST		1096.50	2193.00	3289.50
MAINT & MISC COST PER HR.	.11	55.00	110.00	165.00
TOTAL COST		1151.50	2303.00	3454.50
COST PER HR		2.30	2.30	2.30
COST PER ACRE		3.60	7.20	10.80
ELECTRICITY:				
REA 1977	WHETSTONE			
HP	100			
KW DEMAND	90			
POS.MIN.CHRG.	1008			
EST. TOTAL BILL		2083.00	2758.00	3433.00
FIXED MAINT. (.65)		65.00	65.00	65.00
INSTALLATION CHRG.		?????	?????	?????
TOTAL COST		2148.00	2823.00	3498.00
COST PER HR		4.30	2.82	2.33
COST PER ACRE		6.71	8.82	10.93

The challenge

One of the reasons that automating furrow systems is so difficult is that an outlet is usually required for each furrow. This results in a large number of outlets per unit area, and these outlets must be individually adjusted. The cost of each outlet must be low if the total

Six-inch automated fiberglass valves installed in a buried lateral distribution system.





Twenty-four hour mechanical timers being used to control automatic irrigation valves.

system cost is to be feasible. For a 1320-foot length of run, the number of outlets ranges from about 9 to 13 per acre, depending upon the furrow spacing. A 160-acre field requires about 33 feet per acre of gated distribution pipe and, depending upon the pond or sump location, 8 to 20 feet per acre of return pipe for the surface runoff recovery system. A mechanical-move system can significantly reduce the number of outlets and amount of pipe required, because each outlet and unit of pipe length serves a much larger area. For example, the number of sprinklers on a center pivot lateral ranges from about 0.32 to 0.75 per acre compared to 9 to 13 outlets per acre for a furrow system. The amount of lateral distribution pipe, about 9.7 feet per acre, is also much less. Mainline pipe for both systems is not included in these figures.

Researchers at several locations are experimenting with different types of equipment and techniques for automating surface systems. Valves are needed to automatically control the flow from all of the outlets of a given gated pipe set at one time so that each outlet does not have to be operated individually. Attempts have been made to automatically control the flow from each individual outlet so that a single pipe can be used both for conveying and distributing water to the field, instead of having both a mainline and a distribution line. Although these attempts are continuing, none have been entirely successful or economically feasible because of the large number of outlets involved.

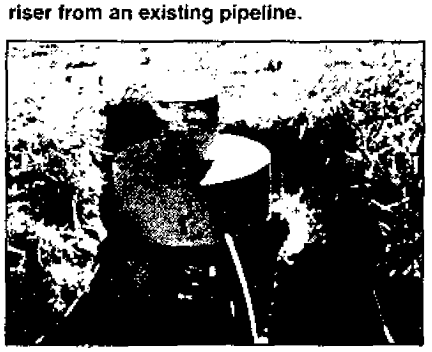
Automatic low-pressure valves for gated pipe are being developed at the Snake River Conservation Research Center. Six-and 8-inch valves have been used for several years; 4-inch and improved 6-inch valves were recently tested. The 6-inch fiberglass valves shown in Figure 1 are being tested with an underground lateral distribution system. They are connected to a riser from a buried mainline and control the flow of water into a buried distribution lateral on either side of the valve pit. The valves use water from the pipeline for operation. They close when a rubber diaphragm or bladder inside is filled with water and open when the water is drained. Water is directed into and out of the bladder by a small three-way pilot valve. Both mechanical (Figure 2) and electronic timers can be used to control the battery-powered motorized pilot valve. When electric power is available, solenoid pilot valves and electric timer/controllers can be used. The 4-inch valve shown in Figure 3, which is attached to a riser on an existing buried mainline, is being used to automate a 14-acre field on the Rudolf Martens farm near Kimberly, Idaho.

The commercial timers were originally developed for use in metering valves for sprinkler systems and are being tested with two commercial prototype models of the Snake River irrigation valve. These timers operate sequentially. When the first valve closes, a signal is simultaneously sent to open the next valve and start the timer for the next irrigation set in the sequence.

Commercial testing

Fiberglass models and commercial prototypes of the Snake River valve and commercial air-inflated valves are being evaluated in an experimental and demonstration irrigation system on a 63-acre field near Twin Falls, Idaho. Both commercial and experimental timer/controllers, including a microprocessor controller, are being tested. The amount of water applied to a crop of beans in 1977 with this system was about 8.6 inches less than that applied by manual irrigation which used 24-hour sets. Socks were used on the gated pipe to control erosion caused by the streams of water discharging from the pipe.

Four-inch automated valve attached to a riser from an existing pipeline.



The automatic valves and their associated controls were also tested on experimental corn and sugarbeet plots at the Research Center. The amount of water applied and the runoff were both reduced compared to non-automated, conventionally-irrigated check plots which were irrigated with 24-hour sets. Irrigation duration was timed with mechanical timers, except on one plot where a tensiometer was used to terminate irrigation. Tensiometer control was satisfactory to begin an irrigation where water was available on demand, but it was not satisfactory for ending an irrigation.

Why automate?

One advantage of an automated system is that furrow streams can be cut back automatically to reduce runoff. In manual systems, cutback is not feasible because of the extra labor required and the problem of handling the extra water not used during the cutback portion of the irrigation.

Several techniques can be used with automation to cut back or reduce furrow stream size. The most common is to pump additional water from a reuse pond during the initial phase of the irrigation and then shut the pump off when water begins to run off the field.

Another method is the split-set technique. The first half of the set is irrigated with the entire stream until water runs off the field. The entire stream is then directed onto the other half of the field for the same length of time. Water is then re-introduced into the furrows of the first half so that the stream is distributed across the entire set for the rest of the irrigation. The split-set technique is also feasible in manually operated systems, because it requires much less labor than adjusting individual pipe gates to reduce the stream size. It requires relatively flat cross slopes where the total elevation difference between the two outer ends of the pipe is less than about 0.4 foot. This elevation difference can be compensated for by rotating the pipe to lower the elevation of the gates on the higher end and to raise the gates on the lower end. The cutback flow from all gates is then about the same. An electronic timer has been developed and tested to control opening and closing of the automatic irrigation valves in the proper sequence, but it's not yet available commercially. ▼