NATIONAL IRRIGATION SYMPOSIUM PAPERS

AUTO-MECHANIZATION OF PIPE DISTRIBUTION SYSTEMS

by

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and

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THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

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AUTO-MECHANIZATION OF PIPE DISTRIBUTION SYSTEMS[1/]

Howard R. Haise and Paul E. Fischbach[2/]

There has been a need for methods to automate surface irrigation systems but difficulties in converting existing irrigation water control structures to remotely operated devices on large farms has seemed insurmountable. Yet, one of the most promising possibilities to utilize irrigation water supplies more efficiently is to provide the irrigator with labor saving devices.

During the past decade, the sprinkler industry has led the way in auto-mechanization of the irrigation of farm crops through its development of solid set and traveling types of sprinkler irrigation systems. Some of these developments are being utilized in auto-surface irrigation today.

In the last five years, the major push in automation of pipeline surface irrigation systems has been in the development of (1) a closure or diaphragm that could automate existing pipe valves or outlets, (2) reliable controllers for remote operation, (3) improved design of automatic valves, and (4) design of reuse systems adapted to automatic irrigation pipelines to achieve higher application efficiencies by recirculating runoff water.

Requirements for Automating a Surface Irrigation System

Minimal requirements which the authors consider essential in the automation of a surface irrigation system are as follows: (1) The system should fail safely in the event that power for operating the system fails, (2) it would be desirable to manually operate the system independently of automated devices, (3) the system should be simple, reliable, and easily maintained, (4) it should sell for a cost the farmer can afford to pay, (5) it should operate at a low cost, (6) it should irrigate a field efficiently and distribute the water uniformly, and (7) it should be capable of applying as little as 2 inches and as much as 6 inches of water per irrigation.

Pneumatic Closure or Diaphragm

The pneumatic closure or diaphragm developed by Haise and Kruse (8, 9), shown in Figure 1, can be made to fit an alfalfa- or orchard-type valve with or without a hydrant. Where furrows are irrigated, the water control point is at each pipe riser. Distribution of water to furrows generally is made by attaching gated pipe to a hydrant which is attached to an alfalfa valve equipped with the pneumatic closure or diaphragm. Discharge to each furrow is controlled by pre-setting the openings on the surface pipe-gates and allowing the pneumatic closure or diaphragm to fully open or close within the limits that the alfalfa valve is set. Pump discharge remains fairly constant with time, thus permitting uniform flow into each furrow. Commercial hydrants attached to alfalfa valves permit manual override of the automatic system in

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case of malfunctions by simply opening and closing the alfalfa valve equipped with hydrant on each irrigation set. Alfalfa valves equipped with pneumatic diaphragms are capable of controlling head pressures, in duo-pipe irrigation systems described below, up to 16 feet with air pressure no greater than 10 psi.

Automation of Duo-Pipe Irrigation Systems

The duo-pipe automatic surface irrigation system requires two pipe lines across the upper end of an irrigation run. An automatic valve is utilized for each irrigation set. One of the pipe lines (main line) can be below or above ground surface, the other pipe line or manifold is on the surface. Each automatic valve is attached to a tee on the main line (Figures 2, 3, 4).

Field Installations

In the spring of 1966, two separate but similar pipe distribution systems were automated with pneumatic diaphragms shown in Figure 1. One system was located near Wiggins, Colorado on the Henry Stroh farm. Here an attempt was made to irrigate a combined acreage of corn, field beans and sugarbeets totaling 78 acres. The other system was located at the University of Nebraska Field Laboratory, Mead, Nebraska, where 10 acres of corn were automatically irrigated. By 1970 the system was expanded to irrigate 70 acres. Table 1 summarizes pertinent information.

Installation at Mead, Nebraska.--The automatic irrigation system at Mead, Nebraska incorporates an auto-surface valve developed by Fischbach (5) that operates on the same principal and utilizes a similar pneumatic diaphragm developed for the alfalfa or orchard valve described above (8). It attaches directly to a pipe riser from the buried pipe distribution system, but differs from the alfalfa valve in that fixed valve seats are incorporated and spaced to provide for maximum discharge. The redesigned valve has provided a more positive seal between pneumatic diaphragm and valve seats. The latest model shown in Figure 4 discharges water from two outlets into surface gated pipe sections. Discharge to individual furrows can be controlled by adjusting each surface pipe-gate. In an emergency, manual override can be achieved by closing all surface pipe gates and alternately opening and closing those required for individual irrigation sets at the appropriate time.

The Mead irrigation system has been operated for four years and uses tensiometers and/or electrical resistance blocks as soil water sensors to start the controller which opens the valve(s) on the first irrigation set and starts the pump. Irrigation water flows from the irrigation well through the buried pipe line and up through the risers and (open) auto-irrigation valve and thence into the surface gated pipe which directs the water down each irrigation furrow.

The rate of water application for each row is set at the maximum allowable furrow stream size without causing erosion (which is approximately three times basic intake rate). The excess water flows out of the field into the field drainage ditch and to the collection pit (see schematic, Figure 5 and photo, Figure 6). Rapid rate of advance of the water through the field will give the best uniformity coefficient of water distribution between the upper and lower end of the field. As runoff water accumulates and rises to a predetermined level in the collection pit for the reuse system located at the bottom of the field, a switch starts the reuse pumping plant to discharge the "waste" water back into the irrigation system. The system is designed so that the collection pit holds most of the runoff water from one irrigation set.

Table 1. Pertinent Information Concerning Automatic Irrigation Systems Installed in Colorado and Nebraska.

	Wiggins, Colorado (Henry Stroh Farm)	Mead, Nebraska (Mead Field Laboratory)
Soil texture	Sandy loam	Silty clay loam
Pump capacity (gpm)	1200	1200
Pipe diameter (inches)	15	10
Riser spacing (feet)	200	60 or 120
Surface pipe diameter (inches)	8	8
Surface pipe connected to each valve (feet)	200	60 or 120
Spacing of valves on gated pipe (inches)	22	30
Furrow spacing (inches)	22 - beets and beans, 30 - corn	30
Length of run	1056	1100
Slope, feet per 100'	Upper end - 0.3' per 100' Lower end - less than 0.1' per 100'	0.2
Reuse system	No	Yes

The reuse pump starts at about the same time that the irrigation controller signals the system to change irrigation sets, and shuts off when the water has advanced through the field on the next set. This provides an automatic cut-back furrow stream. The sequence of operation described continues until the field or fields are irrigated.

Soil water sensors for each field are placed in the first irrigation set of each field and as soon as water penetrates deeply enough to lower the soil water suction, the circuit is opened. A latching relay in the irrigation controller holds the system in the irrigating process until the entire field is irrigated. When the soil water sensor in the next field signals the need for water, the controller switches to irrigate the first set in this field. The sequence described for the first field continues until the last set is irrigated. The controller then shuts the system down. The average time of water application was 2 hours and 15 minutes. This system was considered successful after improvements were made in the controller and the auto-irrigation valve was redesigned. One commercial system was successfully operated during the 1970 irrigation season.

Field Installation at Wiggins, Colorado.--The automatic irrigation system installed and operated in 1966 at the Wiggins location (Figures 7, 8, 9) was similar to that at Mead. The principal difference between this system and the one at Mead is that a reuse system was not utilized. Runoff from applied irrigations, however, was not excessive because of a variable field slope (0.3 foot per 100 feet at upper end and less than 0.1 foot per 100 feet at lower end) that permitted greater intake opportunity on the lower portion of the field. The average time of application was about 6 hours. One irrigation set covered about 5 acres and sufficient gated pipe was available to irrigate four irrigation sets. All furrows were intentionally compacted by running tractor tires in furrows before the first irrigation. After 24 hours' running time, it was necessary to move the gated pipe, hydrant and tone telemetry receiver with a 3-way pilot valve to the next four alfalfa valves equipped with pneumatic diaphragms. It would have been desirable to have sufficient surface gated pipe to irrigate the entire 78 acres, thus eliminating the labor required to move the gated pipe.

Overall performance of the Wiggins automatic pipe system, which was operated by the farmer from mid-season to harvest, was considered to be moderately successful. Improved components and control systems that have since been used in other field installations would have improved operation considerably.

Automatic Controls

The principal difficulties in operating the Wiggins and Mead automatic irrigation systems described above were initially associated with the activation of a 3-way pilot valve using tone telemetry transmitted by wire. At Mead, a small drop in voltage from the main power source caused the telemetry system to change sets. The transmitter was redesigned for use with the Wiggins system (Figure 9), but difficulties in keeping oscillators properly adjusted to activate the tone receivers resulted in automatic shut-downs when all pneumatic valves closed. It was possible to transmit signals by wire for distances up to 3200 feet but 35 volts was necessary to activate the 3-way pilot valve using 18 gauge copper wire.

It soon became apparent that using telemetry first by radio signals (8) and then by wire (9) to remotely operate an automatic irrigation system on the farm was much too complicated for general use. In the second year of operation at Mead, individual wires with a common ground were installed to supply power to operate a 3-way pilot valve at each alfalfa valve riser. A programmer with a clock and stepping switch (Figure 2) has given reliable operation over a 4-year period after initial malfunctions by power failures were eliminated (4). The time required to change irrigation sets with this controller was about 30 seconds. Also no water hammer occurred in the system.

The most recent development has been the adaptation of an electro-mechanical controller[1/] used to irrigate turf grass in public parks and on golf courses where the activating energy can be either water or air. A photo of this controller is shown and described in Figure 10. When operating with air, a special high-capacity rotary valve capable of feeding air to 11 separate irrigation sets has reduced the time required in sequencing valves when switching from one irrigation set to another from 15 to 1 minute compared to the standard controller valve, and has permitted essentially matched opening and closing times. Black polyethylene control tubing, either 5/16" or 1/2" O.D. can be used to open and close valves with pneumatic diaphragms up to one-quarter mile distance.

Automation of Mono-Pipe Irrigation Systems

Automatic gates installed in the mono-pipe system with rigid- or semi-rigid pipe (aluminum or plastic) have the advantage of utilizing a single pipe to transmit and distribute water to furrow-irrigated crops. Although research and development of gated pipe valves are not as advanced as for the auto-surface valves in the duo-pipe system, there are some noteworthy developments.

1/ Manufactured by Toro Manufacturing Company, Riverside, California, 92506. Trade names and company names used in this paper are included for information only and do not constitute endorsement by the U. S. Department of Agriculture.

Mechanical

A new concept in irrigation developed by W. N. Reynolds (13) to irrigate sugarcane in Hawaii is called "Miniwai" or "small water" (see Figure 11). Reynolds describes the system as follows:

"In this system, the conveyance and distribution functions are combined in one channel. The distribution function is accomplished through outlets placed in the bottom of the channel. The conveyance function is accomplished by covering groups of these outlets with a flexible rubber membrane. The membrane is fastened at its downstream edge to the lower portion of the channel. The length of a single membrane determines how many furrows will be served simultaneously. At the upstream edge of the membrane, a wire is attached. This wire, which is controlled by a small hydraulic cylinder, either pulls the upstream edge of the membrane up toward the top of the channel or down flat against the bottom. In the raised position, water must flow under the membrane and out the outlets that were covered by that membrane. In the lowered position, water flows over one membrane and on to the next, where another hydraulic cylinder will cause it either to go out to the furrows or down to the next membrane. The hydraulic cylinder is actuated by a 3-way float valve placed at a predetermined point in a furrow representative of the group of furrows being irrigated. When water reaches the float, it causes the float to rise; this bleeds pressure from the tubing connecting the cylinder to the furrow-end float. This pressure loss, in turn, causes the cylinder to lower the membrane."

The "Miniwai" system is being currently evaluated under field conditions in Hawaii. The 6-inch diameter of channel permits a flow rate of 720 gpm on a 5 percent slope. The membrane is neoprene-coated nylon fabric, with 20 mil thickness. Plastic cylinders[1/] having a differential area that can be operated using a 3-way valve are being used to remotely actuate the water control mechanism.

Fischbach (5) utilized an air cylinder connected to cables and/or rods to open and close sliding pipegates in four 30-foot lengths of 8-inch diameter aluminum pipe. Each 30-foot length of gated pipe had 12 gates or a total of 48 gates for each irrigation set. The system worked fine in the laboratory, but problems were encountered in the field. Periodic adjustments were needed to counteract expansion, contraction and deflection in the aluminum gated pipe in order to keep pipe gates operating properly. Another system utilized a hydraulic cylinder for each 30-foot length of pipe with 12 gates and later a cylinder for each 3 gates. However, it was concluded from these studies that a single driver was needed for each sliding gate.

Hydraulic

The normally closed plastic pipe gate[1/] (Figure 12) is constructed from Cycolac and operates on water pressure fed through 1/4" O.D. polyethylene tubing. When pressurized, the valve lid opens inside of the pipe in which it is installed. Discharge can be adjusted externally. Maximum discharge at 2 feet of head is about 75 gpm. When depressurized, the internal valve lid closes by a spring return action. Valves can be manifolded using 1/4"

1/ Manufactured by Toro Manufacturing Company.

polyethylene tubing to open and close the number required for an irrigation set. Control manifolds can be placed inside or outside of the surface irrigation pipe.

Pneumatic

Figure 13 shows an experimental pipe-gate that has been adapted to aluminum pipe for control of discharge to individual furrows. Basically, the pipe-gate utilizes a commercially available, manually operated valve known as the "Epp-fly gate."1/ Modifications of this valve consisted of cutting the "sock" adapter in half. The innermost portion was sealed into the valve body with epoxy cement. The external portion was mounted in the lid of the metal transition box as shown. It was necessary to add an O-ring to the adjustable lever to prevent leakage when the pneumatic valve was inflated. Discharge from the valve fully opened was 40 gpm at a head of 3 feet compared to 57 gpm from the same pipe-gate with pneumatic valve and lid removed. It is believed that discharge can be increased with improved design of the metal transition box.

Overall performance of the automated pipe system (Figure 13d) with reuse pump in operation was not up to expectations. One problem was associated with the 2.5 percent slope on which the automatic system was operating. Furrow flow rates of 3-5 gpm required such a small opening in the gate valves (about 1/4 inch) that debris in the water returned by the reuse system gradually collected in the valve opening. As a result, flow to furrows receiving reuse water gradually diminished. Obviously, such occurrences cannot be tolerated in the operation of any automatic irrigation system. With larger flow rates on lesser slopes, the problem would be nonexistent.

Another possibility for automating pipe distribution systems is shown in Figure 14. Here plastic hydrants with pipe-gates mounted on the outer wall offer a compromise between an automated duo-pipeline system with buried pipeline distribution system and a portable surface automated mono-pipe system. The hydrants are solvent-welded to an 8- or 10-inch buried PVC line at intervals that are even multiples of furrow spacing. With alternate-furrow irrigation of field beans, the risers and hydrants, each containing three pipe-gates, were spaced on 11 foot centers as shown. Pipe-gates installed in hydrants permit individual adjustment of discharge rate to each furrow. The pneumatic valve attached to the lid of the hydrant (Figure 14a) uses a volley ball bladder and nylon reinforced butyl rubber casing as an inflatable pillow to control discharge.

Discussion

Cost of Automated Irrigation Pipe System

Farmer acceptance of any automated irrigation system will depend upon the capital investment he must make in relation to the cost and/or availability of labor. The cost per unit area for an automated irrigation system will depend upon soil and crop conditions. Obviously, systems that can be efficiently operated on fields with one-half mile runs will cost less than if the runs are only one-quarter mile long or less. Fischbach estimates that a duo-pipe automatic system with a reuse pumping plant would cost $16,000 for 160 acres if furrows are one-quarter mile long. It does appear that this cost can be reduced by foreseeable changes in components.

1/ Manufactured by Henderson Manufacturing Company, Inc., Henderson, Nebraska, 68371.

Automated mono-pipe irrigation systems must consider the same factors mentioned above but where used on newly irrigated lands have the advantage of substituting the cost of the buried pipe for automatic pipe-gates. It is too early to make cost estimates since only one plastic pipe-gate is in the development and testing stage. It remains to be seen how much other types of valves, some of which were described earlier, will cost when produced in large quantities.

Reuse System Required for Efficient Operation

Fischbach and Somerhalder (7) have conducted studies to show that reuse systems are an essential part of any automatic irrigation system if high application efficiencies and uniformity coefficients are to be attained. Measured uniformity coefficients ranged from 86.5 to 95.4 on three replicated treatments and averaged 91.8. Water application efficiencies ranged from 84.4 to 96.8 and averaged 91.9 percent for all irrigations. Without reuse or cutback irrigation systems and with automatic water application the average application efficiency was 64.8 percent. Applied water lost as runoff was 27.1 percent.

The high application efficiencies attained with automatic irrigation systems used in conjunction with reuse systems is noteworthy when compared with farm irrigation efficiencies of 31 to 52 percent reported by the U. S. Bureau of Reclamation where conventional irrigation systems were used.

Alternate vs. Every-furrow Irrigation

Automatic releases of water to furrows from gated-pipe outlets would be less difficult and less expensive to install if alternate furrows could be irrigated without sacrificing crop yields. Scattered results indicate that such a management practice might be considered under certain soil, climate and cropping conditions. In Texas (1, 2, 10, 11, 12), yields of potatoes, cotton, grain-sorghum and grain-sorghum-wheat were not significantly different where alternate-furrow or "variable row spacing" treatments were compared to the every-furrow treatment.

In Nebraska, Fischbach and Mulliner (6) found that alternate vs. every-furrow irrigation gave no significant difference in corn yields regardless of soil type (Table 2). Furthermore, for the Holdrege silt loam and Ortello loamy sand, alternate furrows that were alternately irrigated each time water was applied gave no significant yield difference compared to irrigating the same alternate furrows for the entire season. The alternate furrow treatment received only one-half as much applied water as the every-furrow treatment. The duration of irrigation sets was approximately 12 hours using a manually operated gated-pipe system. These results were obtained where seasonal rainfall varies between 22 to 32 inches per year with 8 to 14 inches occurring during the growing season.

Table 2. Corn yields on various soil textures when irrigating every furrow and alternate furrows with a surface irrigation system (7).

Soil Type	Furrow Spacing inches	Intake Rate (estimated) in/hr	Every Furrow Bu/Ac	Alternate Furrow (same) Bu/Ac	Alternate Furrow (alternated) Bu/Ac
Albaton Clay loam	40	High 1.0	157	154	---
Luton Silty clay loam	40	Low 0.20	152	159	---
Crete Silty clay loam	40	Low 0.20	153	156	---
Holdrege Silt loam	30	Mid 0.32	179	177	174
Sarpy Sandy loam	40	High 0.55	140	143	---
Ortello Loamy sand	40	High 0.70	118	119	120
O'Neil Loamy sand	40	High 0.70	114	107	---

Conclusions

The following statements summarize the authors' conclusions based upon the present "state of the art" for automating pipe irrigation distribution systems:

1. A reliable automated surface irrigation system has been developed and tested.

2. At the present, the estimated cost of this system is comparable to the self-propelled center pivot and less than automated solid-set sprinkler irrigation systems. However, cost reductions of basic components for the duo-pipe surface irrigation system are foreseeable.

3. It is essential that a reuse system be considered as an integral part of surface automated pipe irrigation systems for most efficient use of water. With proper design of the reuse pump, an automatic "cut-back" in furrow-flow rates can be obtained.

4. A combination of the reuse and automated surface-pipe irrigation systems has resulted in high water application efficiency and uniformity coefficient (average for each about 92 percent). Depths of water application attained range from 1.5 to 2.0 inches for each irrigation.

5. Before selecting a surface or sprinkler automatic irrigation system, the irrigator should carefully consider his soil, crop, climatic and topographic conditions to obtain the most efficient and economical unit to satisfy his specific needs.

6. Automated surface irrigation systems are best adapted to slopes of less than 1.5 percent, and to soils with a medium to low intake rate. Even sandy loams can be irrigated effectively with an automated surface irrigation system if the furrows are compacted with a special tool prior to the first irrigation.

7. The power requirements for operating a sprinkler irrigation system are considerably greater than required for automated surface irrigation systems.

8. Automated surface irrigation pipe with a reuse system can be used efficiently to apply fertilizers in the water since high coefficients of uniformity are attained and the runoff water is reused.

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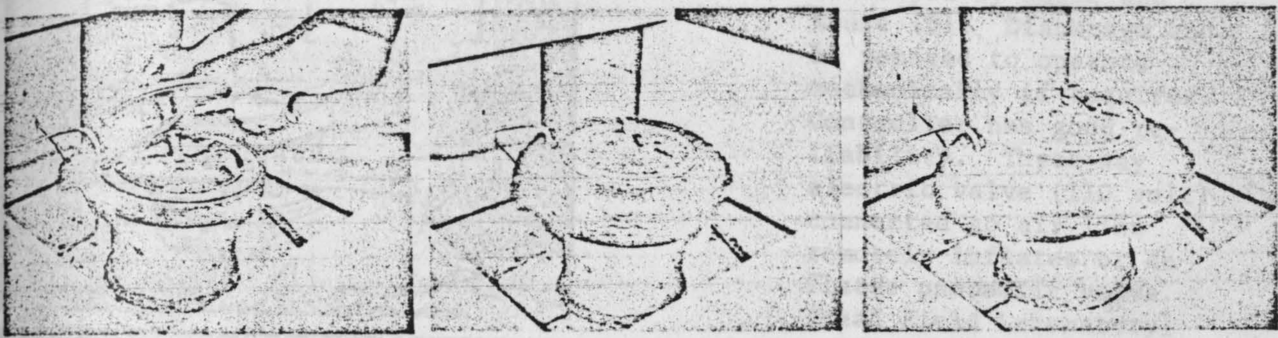


(a) (b) (c)

Fig. 1. Pneumatic nylon reinforced butyl rubber diaphragm:
(a) being installed on alfalfa valve riser,
(b) in an inflated or closed position, and
(c) deflated to allow discharge of water to occur (8).

The pneumatic diaphragm is held in position by a centrally located metal sleeve capable of sliding up and down the threaded screw supporting the valve lid. In an open position, the diaphragm is forced against the bottom of the valve lid and appears to "ride" on top of the water flowing from the alfalfa valve. In an inflated or closed position, the diaphragm forms an annular seal against the valve seat and valve lid. About 5 to 10 pounds per square inch of air pressure in the pneumatic diaphragm are usually sufficient for most pipeline distribution systems. (Patented May 23, 1967.)

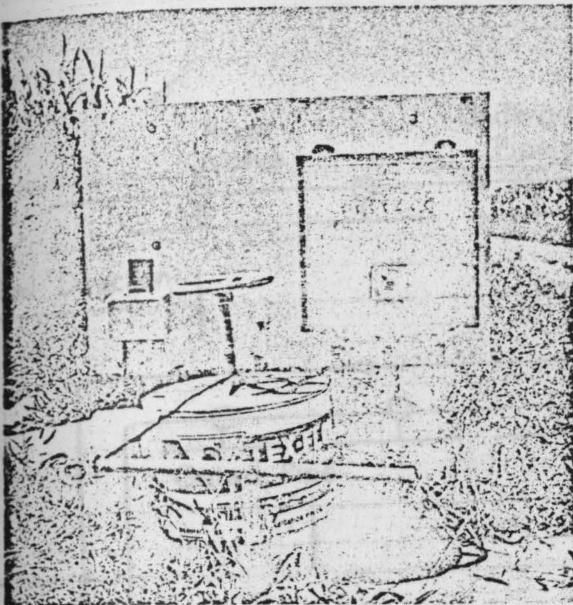


Fig. 2. Auto-surface valve and controller (5) being used to irrigate corn at Mead, Nebraska. Valve utilizes pneumatic diaphragm developed by Haise and Kruse (8). Diaphragm can be removed to operate mechanically if required. Controller has good reliability. Three-way electric valve (110 volt) connected to air line remotely inflates or deflates pneumatic valve. (Mead Field Laboratory)

Fig. 3. Auto-surface valve (1968-69 model) with single outlet. In event of automatic malfunction, internal pneumatic diaphragm can be deflated and gated pipe outlets used in normal fashion to manually control flow to furrows. When on side slope, gates will require adjustment to obtain same discharge to each furrow. Cost of system installed is about $16,000 for 160 acres. (Mead Field Laboratory)

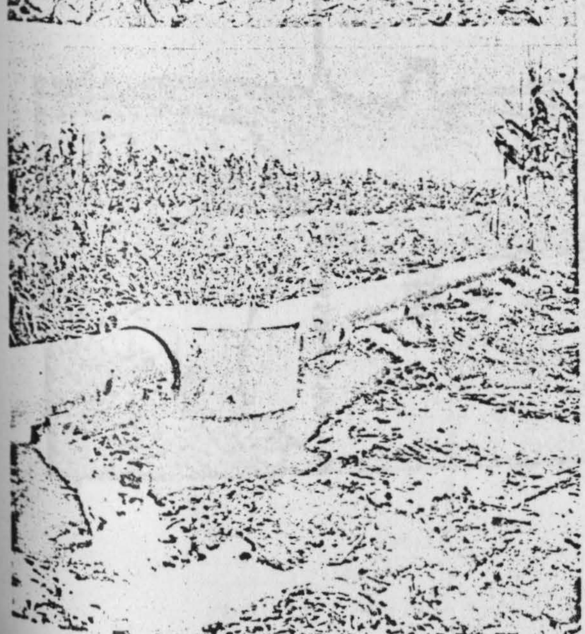


Fig. 4. Auto-surface valve (1970 model) with double outlet. A one-half inch polyethylene pipe connected between controller and pneumatic valve controls discharge by regulating the flow of air to inflate or deflate the pneumatic valve.

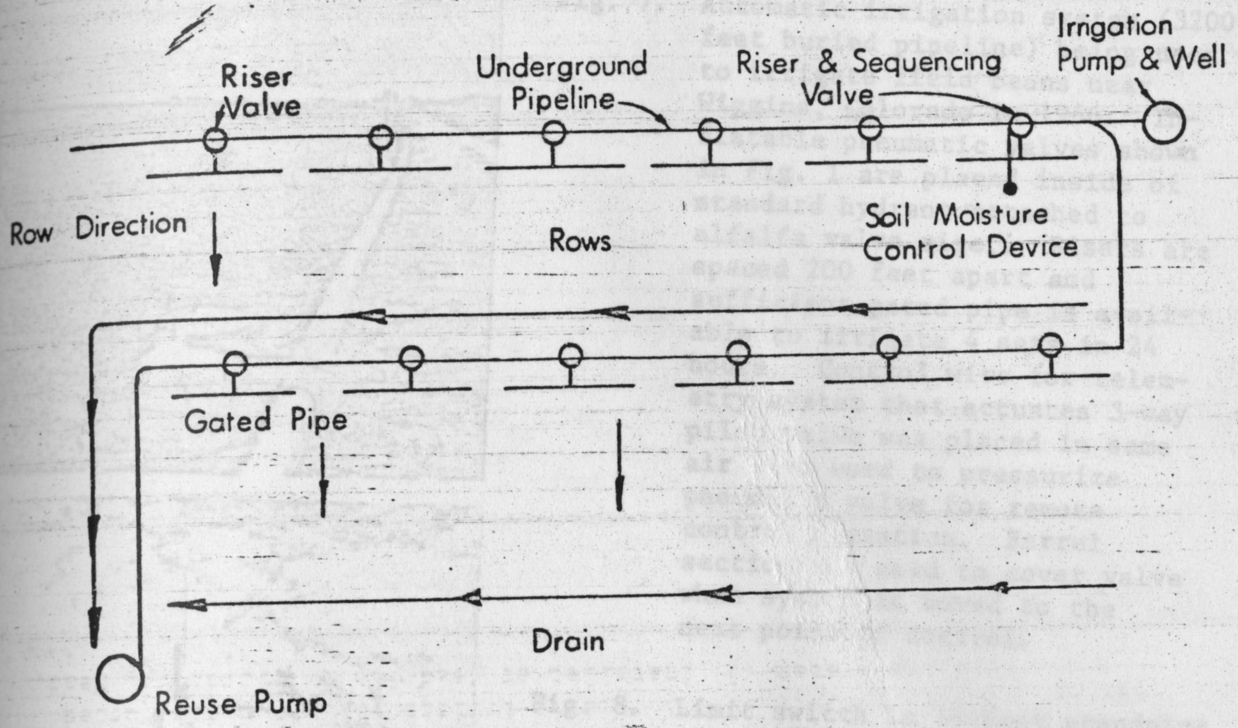


Fig. 5. Schematic diagram of automatic irrigation system for buried pipeline system (3) installed at Mead Field Laboratory, Mead, Nebraska.

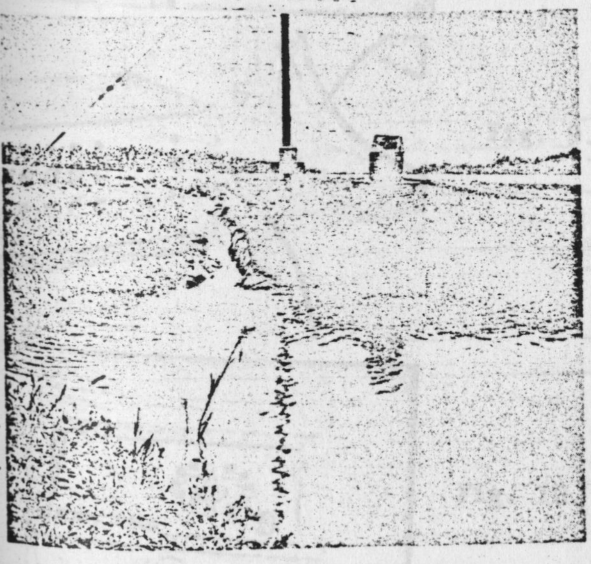


Fig. 6. Reuse system (3) installed in 1966 is used in conjunction with automated irrigation system shown in schematic diagram (see Fig. 5). Air cell limit switch operates controls on power pole to start and stop reuse pumping plant. (Mead Field Laboratory)

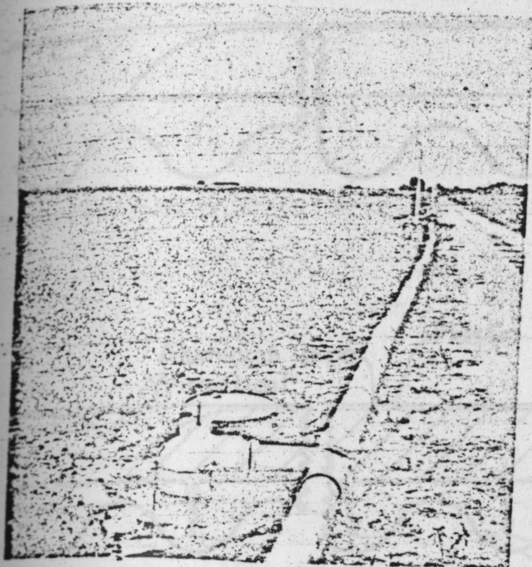


Fig. 7. Automatic irrigation system (3200 feet buried pipeline) being used to irrigate field beans near Wiggins, Colorado in 1966. Inflatable pneumatic valves shown in Fig. 1 are placed inside of standard hydrant attached to alfalfa valve riser. Risers are spaced 200 feet apart and sufficient gated pipe is available to irrigate 4 sets in 24 hours. Control wire for telemetry system that actuates 3-way pilot valve was placed in same air line used to pressurize pneumatic valve for remote control operation. Barrel section was used to cover valve when system is moved to the next point of control.

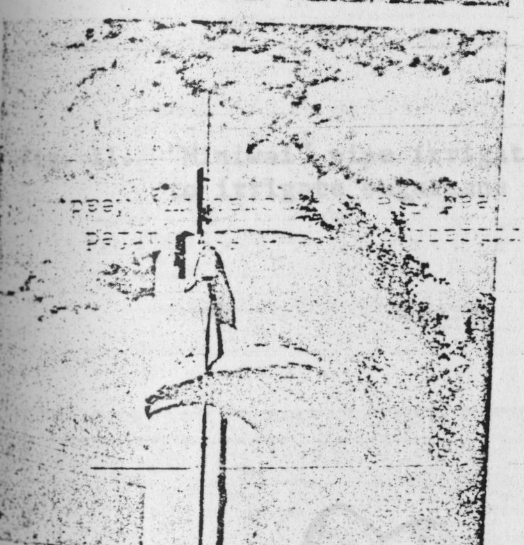


Fig. 8. Limit switch in 16-foot standpipe at pump site automatically turns off pump in the event that an all pneumatic close due to malfunction of telemetry system.

Fig. 9. Electronic timer, controller and pressure regulator sequencing valves on 4 irrigation sets. Tone receiver shown in Fig. 7 next to hydrant is portable. Additional control positions can be added to match the number of sets required.

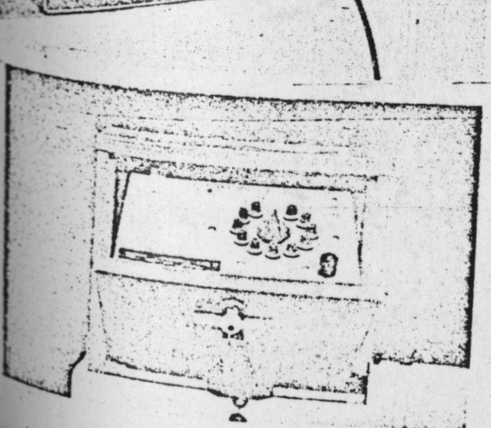


Fig. 10. Electro-mechanical controller has capability of pre-setting time interval up to 9 hours on 11 separate irrigation sets. Air or water can be used as the energizing fluid.

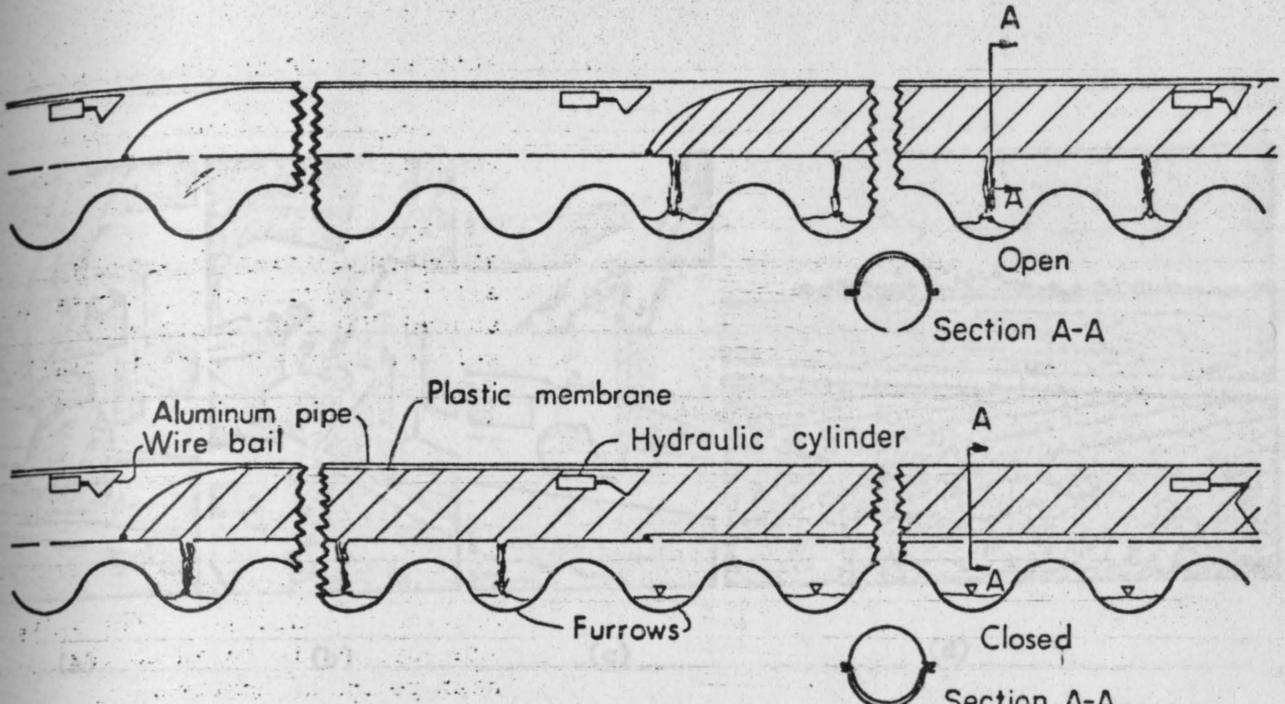


Fig. 11. "Miniwai" pipe irrigation system developed by W. A. Reynolds, HSPA, to irrigate sugarcane in Hawaii (13).

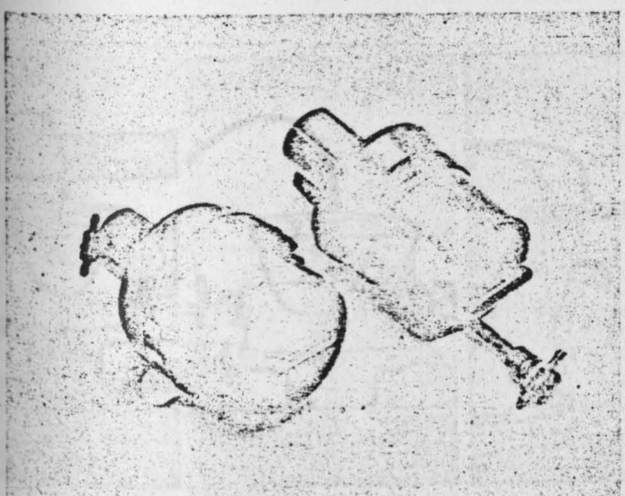
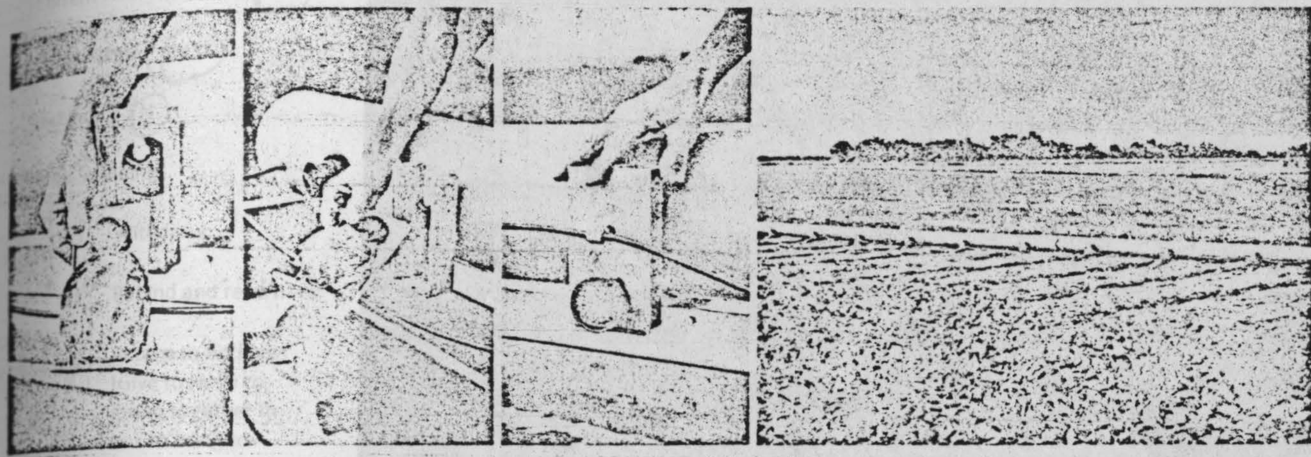
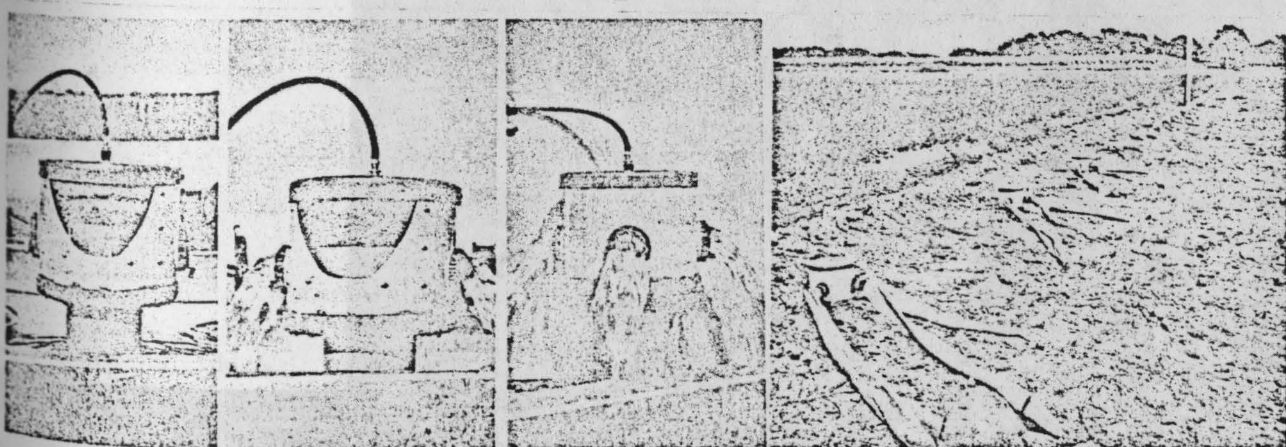


Fig. 12. Plastic pipe-gates showing internal and external connectors for coupling into a manifold. The outlet of pipe-gate is 2" in diameter and discharge can be regulated by handle centrally located in outlet.



(a) (b) (c) (d)

Fig. 13. Pneumatic diaphragm or "pillow" developed by ARS-SWC, Ft. Collins, Colorado, to remotely control releases of water from gated pipe valves: (a) Deflated nylon reinforced butyl rubber cover with bladder, (b) same as (a) but inflated, (c) pneumatic valve in position on gated pipe, (d) section of automatic gated pipe being used to irrigate field beans at Scotts Bluff Experiment Station, Mitchell, Nebraska.



(a) (b) (c) (d)

Fig. 14. Pneumatic diaphragm or "pillow" developed by ARS-SWC, Ft. Collins, Colorado, installed in a P.V.C. riser and hydrant as seen through plastic window (a) in an inflated or closed position, (b) partially deflated to allow discharge to commence, (c) discharge from three manual pipe gates, and (d) field installation at Scotts Bluff Experiment Station, Mitchell, Nebraska.