

# OPERATION AND CONTROL OF SPRINKLER SYSTEMS

By James A. Watkins, Director of Training, Telsco Industries

## Part Two: Sprinkler Equipment

Control, or operation, of system zone valves may be manual or automatic.

### MANUAL CONTROL

Manually controlled turf sprinkler systems use standard commercial globe valves. Globe valves of either the straight or angle type are acceptable. Angle valves are most commonly used because there is much less pressure loss through this type.

Never use gate valves for zone operating valves. They are not intended for continual use and will soon leak if subjected to such use.

Globe valves with swivel disc holders and soft rubber discs for cold water service should be specified in order to avoid an abnormal amount of maintenance. Brass-to-brass seats inevitably leak under continuous use. Stems should be heavy enough to support key operation without breaking. Stem packing should be generous. Ports through the valves should be full-size to minimize pressure loss.

Manual control valves may be decentralized for economy or manifolded at a central point for control convenience. The latter is more costly, especially on large installations. However, it is accepted practice on residential lawn systems. In any case, manually operated zone control valves should be located so the operator will not get wet, even with wind.

When the valves are manifolded, one group, controlling front yard zones, is usually installed near the front entrance. A second group for the back yard zones is manifolded next to a patio or rear entrance. The two manifolds are then connected by a single supply line from the meter or other source of water supply. See Figure 11.

### AUTOMATIC OPERATION

Automatic turf sprinkler systems have a great advantage over manual control. They offer complete independence from watering chores, release time for leisure, provide continuity of the watering schedule during periods of owner absence, save water, and save the cost of labor on larger

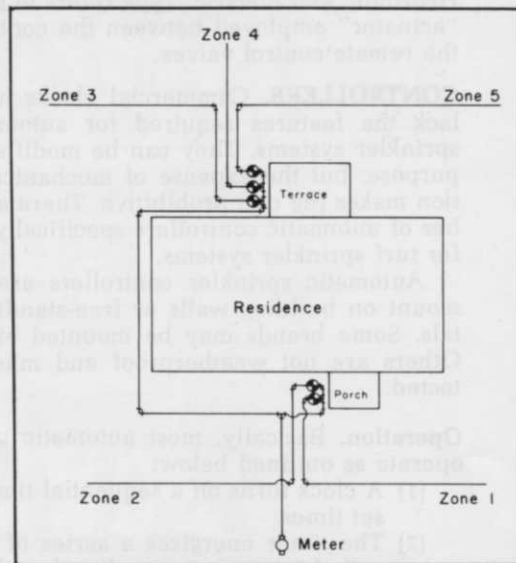


Figure 11: System using standard commercial globe valves.

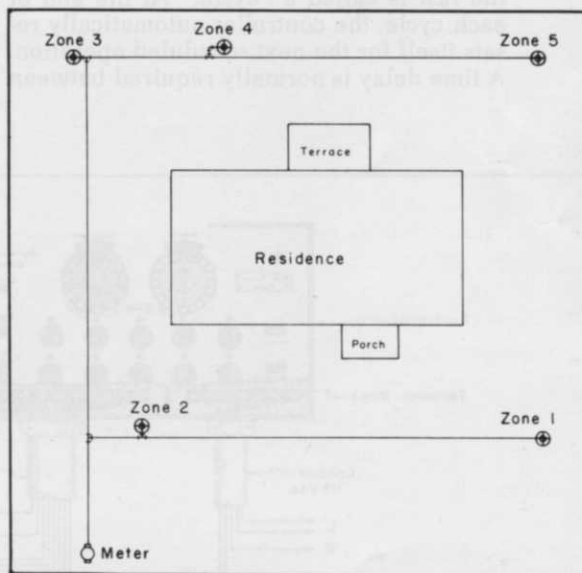


Figure 12: System using remote control valves.

properties. Automatic systems now comprise a majority of the new installation market. The cost over manual control amounts to only a few dollars annually when the added cost is amortized over a twenty year life. These small sums can be recovered in water savings alone!

Automatic control consists of a conveniently located "controller" which operates "remote control valves." One valve is required for each watering zone.

The remote control valves are dispersed throughout the system, thereby saving considerable quantities of piping. See Figure 12. The valves are usually installed at the side entrance to a zone or at the center of a zone, depending on how the main supply pipe is routed. Thus, they are also

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more efficient and conserve pressure lost in the longer pipe runs of globe valve systems.

There are two types of automatic system: *Hydraulic* and *Electric*. Type refers to the kind of "actuator" employed between the controller and the remote control valves.

**CONTROLLERS.** Commercial clocks and timers lack the features required for automating turf sprinkler systems. They can be modified for this purpose, but the expense of mechanical renovation makes the cost prohibitive. There are a number of automatic controllers specifically designed for turf sprinkler systems.

Automatic sprinkler controllers are made to mount on building walls or free-standing pedestals. Some brands may be mounted either way. Others are not weatherproof and must be protected.

**Operation.** Basically, most automatic controllers operate as outlined below:

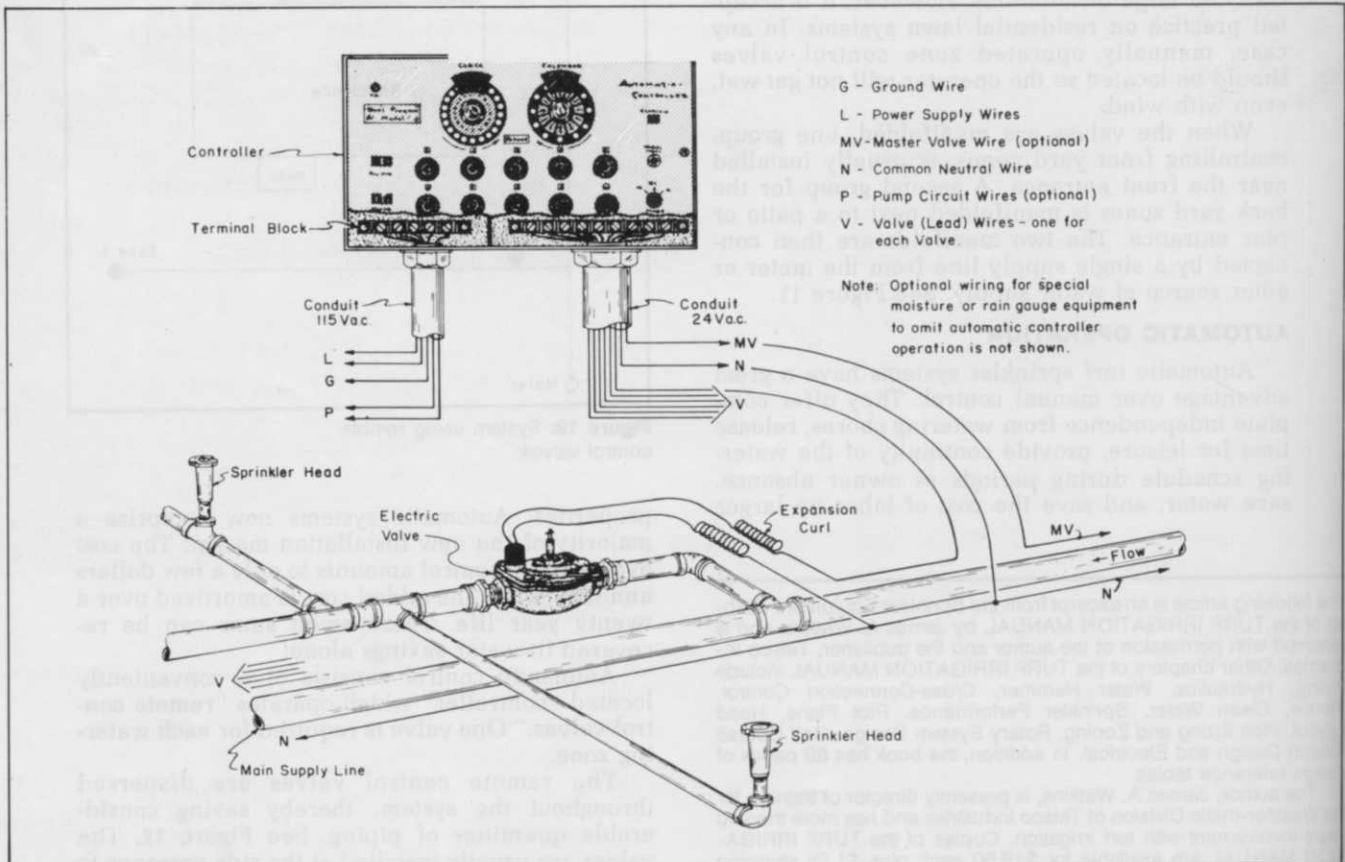
- (1) A clock turns on a sequential timer at pre-set times.
- (2) The timer energizes a series of terminals called "stations," one after the other and in sequence. The entire automatic progression of energizing stations from the first to the last is called a "cycle." At the end of each cycle, the controller automatically re-sets itself for the next scheduled operation. A time delay is normally required between

the ending of one cycle and the clock start of another.

- (3) Each zone valve is connected to one of the stations in a pre-selected watering sequence. When a station is energized, the remote control valve is actuated and sprinkling occurs in that zone for a pre-set period of time.

**Standard Controller Features.** Good automatics will have these features:

- (1) An easily adjusted clock monitor for starting the watering cycle at any hour of the day or night.
- (2) A calendar dial for programming automatic water cycles on any day or days on a repeating 14-day period.
- (3) Sequence timer with variable time that can be easily adjusted for a minimum time limit of not more than 5 minutes. Maximum water time should be not less than 30 minutes for spray systems and 60 minutes for rotary systems. Timing should be independently variable for each station.
- (4) Semi-automatic performance, so that the automatic progression cycle can be started manually without disturbing the clock setting. Control should automatically shut off at the end of the manually initiated cycle and re-set for the next scheduled operation.
- (5) Manual operation of each station, at ran-



**Figure 13:** Typical wiring connections for electric controllers.

dom or in sequence independent of the automatic timer, with switches or other types of selectors.

- (6) A master switch, sometimes called a "rain switch," which can be set to prevent the automatic watering cycle from starting during periods when watering is not required or wanted. Use of the master switch should not affect the pre-set program.
- (7) Station omit whereby, at discretion of operator, any station or stations can be omitted from the automatic or semi-automatic watering cycle.
- (8) Designed so that all programming and operational settings can be easily made on the face of the controller with switches, knobs, etc.
- (9) A safety device, such as a solenoid, for hydraulic systems using normally-open remote control valves to shut the system off in the event of electrical power failure.
- (10) Instructions for field servicing.
- (11) Availability of repair parts.

**Optional Controller Features.** Many brands of automatic controllers also provide optional features. (Note: some brands may provide some of these features as standard.)

- (1) A master valve circuit to provide for operation of a "master" remote control valve at the entrance to the entire system. The master valve automatically opens when any controller station is energized. It is intended to be used in conjunction with certain types of backflow prevention devices.
- (2) A pump control circuit to energize a pump whenever a station is energized. Some brands of controllers also provide a means of operating the pump for purposes other than sprinkling.
- (3) Dual programming which allows any pre-selected station to be omitted from the automatic or semi-automatic cycle on any day or days of the calendar program. This feature is generally used to allow less frequent watering of shrubbery areas.

With some controllers, stations watered on the secondary program must be selected at time of installation. For all-electric systems, a separate, special wire is required for all remote control valves on the secondary program. Valves cannot be added to or eliminated from this program after installation. However, some brands of controllers do not require the extra wire. And, valves can be added to or eliminated from the program at any time. Re-programming is accomplished by a simple rewiring procedure at the terminal block in the controller. This versatility is preferred in most cases.

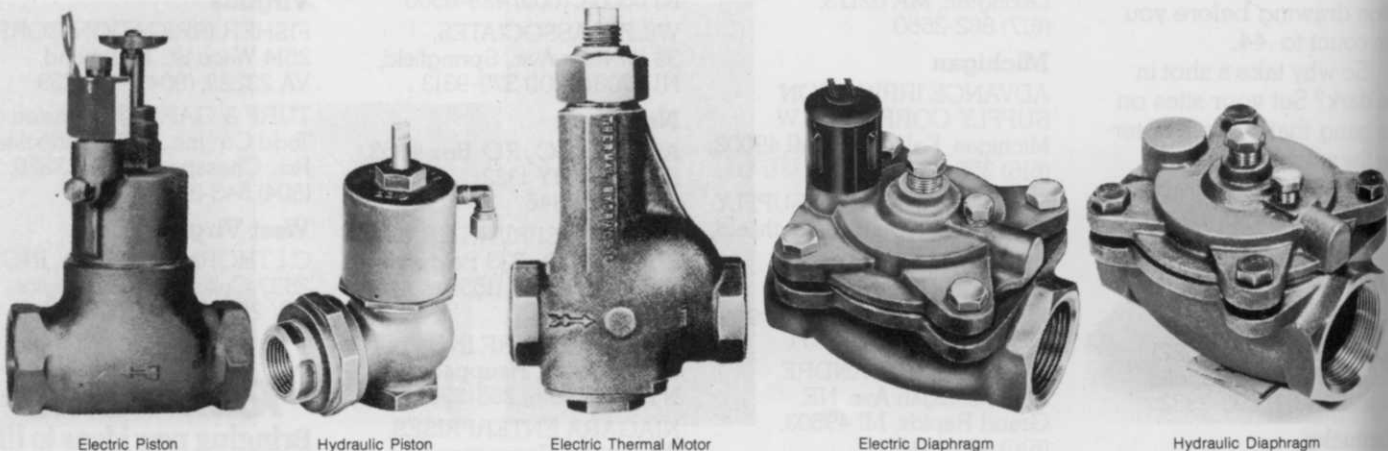
- (4) In addition, specialized controllers are available for very large area watering such as golf course, park, etc.

**Note:** On larger systems, more than one controller is often used. Some reasons for using multiple controllers are:

- (1) Number of zones exceeds the capacity of a single controll.
- (2) Different equipment is used in some areas being sprinkled and separate control is desired for each.
- (3) Separate programs of watering are desired or required for certain areas of property. For example, greens and fairways of golf courses.

**REMOTE CONTROL VALVES.** Valves specifically manufactured for automatic turf irrigation systems are completely buried, therefore less conspicuous. However, there had been a definite trend in recent years to enclose the valves in specially-made boxes, particularly those of larger systems. Such installation makes it easier to locate and service the valves when required.

The most important reason for installing remote control valves in burial boxes is to simplify servicing and operation inspection of the sprinkler heads. Most valves have a "bleed-plug" or other device incorporated in the top to permit



Electric Piston

Hydraulic Piston

Electric Thermal Motor

Electric Diaphragm

Hydraulic Diaphragm

**An assortment** of valve types used in turf sprinkler systems.



manual opening and closing. This feature eliminates wasted service time for trips back and forth to the controller location.

Most remote control valves are constructed entirely of brass and bronze. Some have a body casting and bonnet of cast iron which is subject to considerable rusting. However, brass functional parts tend to reduce the overall effect. Recently, some manufacturers have begun to produce plastic remote control valves.

Remote control valves are made on the globe valve pattern almost entirely; the straight type being the most prevalent.

**Diaphragm-Type Valves.** The most commonly used remote control valves for both electric and hydraulic control are the diaphragm type. For the controller to operate these valves, a water pressure differential must be maintained between the top-side and under-side of the diaphragm. For trouble-free operation, a quality diaphragm is required which won't allow uncontrolled leakage from one side to the other. Quality diaphragms made of such materials as Buna-N reinforced with nylon webbing are practically indestructible.

There is practically no wear in diaphragm valves. Therefore, parts seldom require renewal. There is no swivel motion on seats to cause leakage as in the case of most types of globe valves. Because of this factor, the seat disc can be molded as a part of the diaphragm to further simplify the valve and reduce the number of parts. See Figure 14 and Figure 16. In addition, diaphragm valves do not have stem packing, a frequent source of valve leakage.

**Piston Valves.** As the name implies, these valves utilize a vertically moving "piston" to open and close the valve. Like diaphragm valves, a pressure differential must be maintained between the top and bottom of the piston for proper operation. Leather or composition cup washers or "O" rings around the piston prevent leakage past the piston (similar to operation of piston rings in an automobile engine).

Leather cup-washers have a tendency to dry out between seasons and shrink away from the "cylinder" walls. When this condition occurs, pressure by-passes the cup-washers causing the valve to become inoperative. "O" rings tend to roll and twist when the valve opens and closes. Excessive wear and deformation caused by this malfunction requires frequent replacement of the "O" rings. Valves using leather cup-washers or "O" rings are also subject to "sticking" after long periods of non-use.

**Electric Thermal Motor Valves.** This type valve does not use water pressure to open or close. Rather, a thermal (heat) motor directly operates the valve.

**Flow Adjustment.** Most sprinkler system remote control valves include a flow adjustment device. With some valves, this is an optional feature; others provide it standard. This feature is used to reduce flow and pressure to small zones in order to balance them hydraulically with larger zones. Most flow adjustment devices can be used for complete manual shut-off of the valve.

**ELECTRIC AUTOMATIC SYSTEMS.** Turf sprin-



Typical controller operational panel.

kler systems using electricity transmitted from the controller by wires to operate the valves are classified as "Electric Automatics."

**Wiring.** Electrically operated valves manufactured specifically for turf sprinkler systems require less than 30 volts to operate; usually 24 volts. Direct underground burial of UF or TW wires (UF is preferred) without conduit is safe with less than 30 volts. However, always check local electric codes before designing systems.

Figure 13 illustrates the electric wiring between the controller and electric remote control valves. One "hot" wire is required to each valve from the "station" terminal that controls it. A "common" wire to all valves is the second "leg" of the electrical circuit. Wire sizes depend on the length of wire to the valve and the current requirements of the valve.

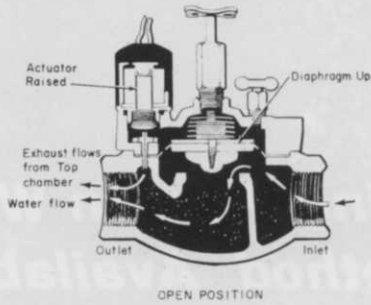
The electric current "draw" of different brands of valves and the current requirement of different controllers vary. Therefore, wire sizes must be carefully calculated. Most manufacturers furnish tables or other recommendations to simplify controller to valve wire sizing.

Extreme caution should be exercised when "mixing" different brands of controllers and valves. Be sure the controller can supply enough power for the valve and use care in sizing wiring. Brand "mixing" of controllers and valves is normally not recommended.

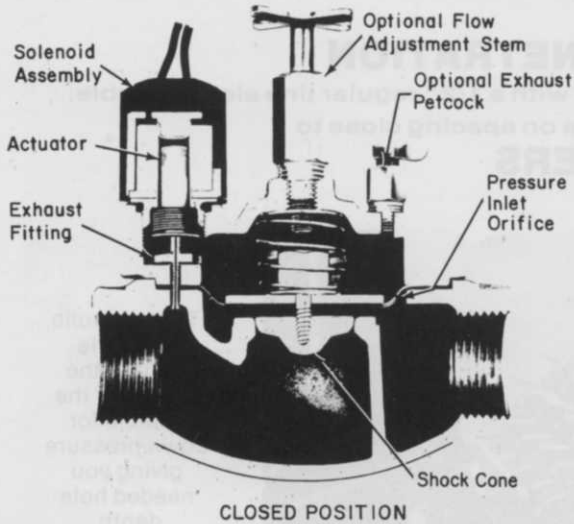
Some systems (usually large ones) are designed with one station of the controller operating more than one remote control valve. Before designing such a system, check the capabilities of the equipment that will be specified.

Many controllers for electric automatic systems have this capacity, but the number of valves which can be operated varies from model to model. Multiple valves on a single station require larger wire than for a single valve. And, wire sizing is more critical. Again, follow the manufacturer's recommendations.

**Operation: Electric Solenoid Diaphragm Valves.**



OPEN POSITION



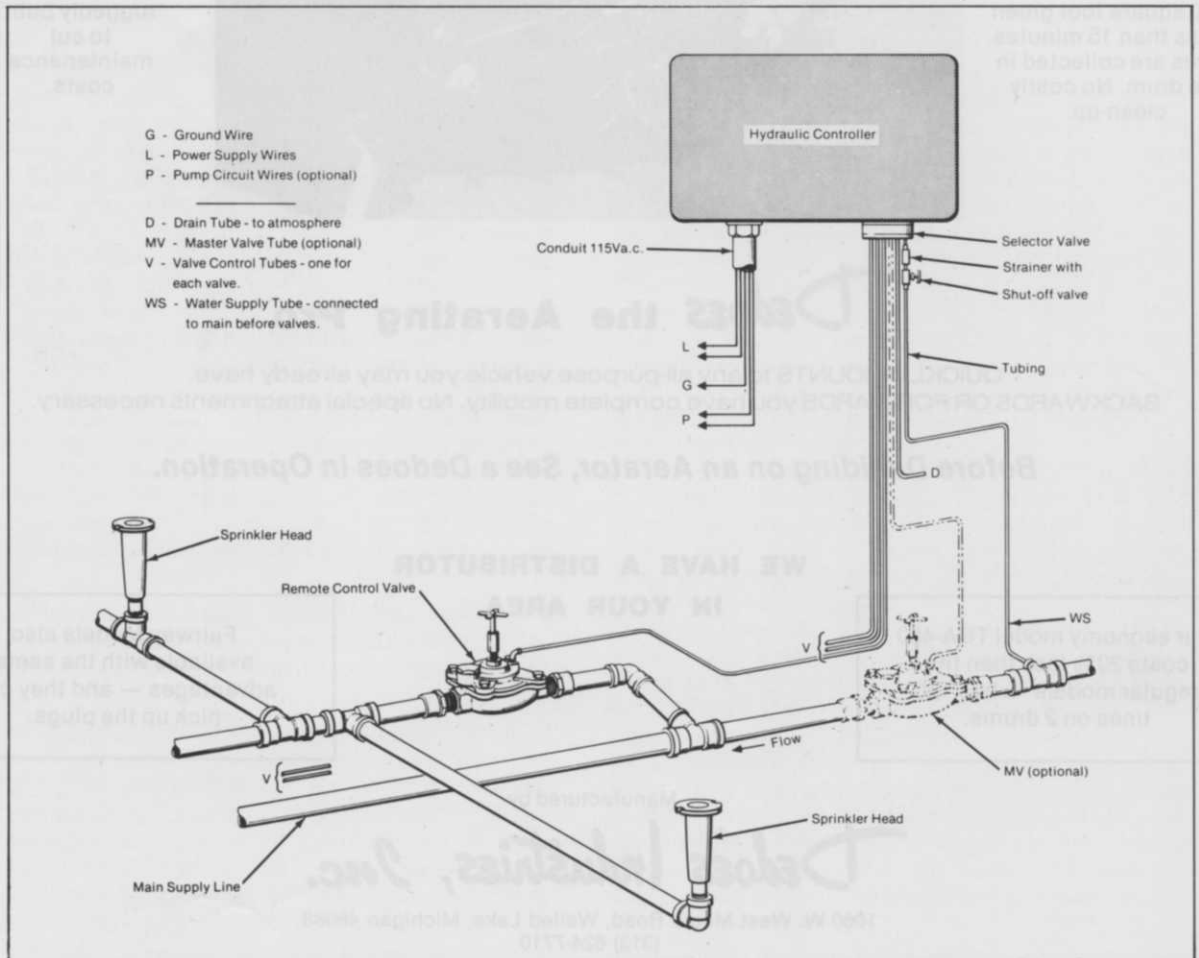
When a valve is not being operated (Figure 14, closed position), water under pressure from the sprinkler system "main" pipe line holds the valve closed.

When a controller "station" wired to a valve energizes the solenoid, the magnetic force lifts its actuator off the exhaust port. The pressure of water in the upper (hydraulic) chamber is relieved through the exhaust port which allows the "main" pipe line pressure to force the flexible diaphragm up, opening the valve. (Figure 14, open position).

Because a loss of water pressure occurs as water flows through the body of the valve, pressure is greater at the entrance of the inlet port to the upper chamber than at the chamber outlet port. The sizes of the two ports are correlated so water can flow out the exhaust faster than it can enter the upper hydraulic chamber. Therefore, service technicians should be cautioned to never tamper with

**Figure 14:** Electric solenoid diaphragm valves, open and closed.

**Figure 15:** Tubing installation for a hydraulic controller.



the port sizing for any reason.

When the controller "station" and solenoid are deenergized, the actuator drops, closing the exhaust port. Pressurized water entering the upper (hydraulic) chamber forces the diaphragm down, closing the valve.

Sprinkler system water must be clean of debris that could cause the inlet port to be blocked. If this should happen, water could not flow into the upper (hydraulic) chamber and the valve would remain open. Some valves use an inlet port strainer to keep out larger debris. However, screens can be blocked by build-up of fine debris.

Other valves utilize an inlet port directly through the diaphragm. Large debris that could block the port is normally dislodged as the diaphragm flexes during valve opening and closing. Debris smaller than the inlet port is free to pass through. Since the outlet port is larger than the inlet port, any debris passing through the inlet port will pass through the outlet port.

**Operation: Electric Thermal Motor Valves.** While wiring requirements are the same as for "Electric Solenoid Diaphragm and Piston Valves," the principle of valve operation is completely different. The valve is made on the straight-globe pattern.

When the valve is not being operated, a strong spring forces the seating disc against the body seat, holding the valve closed. A shaft is attached at the bottom to the seating disc and at the top to the motor.

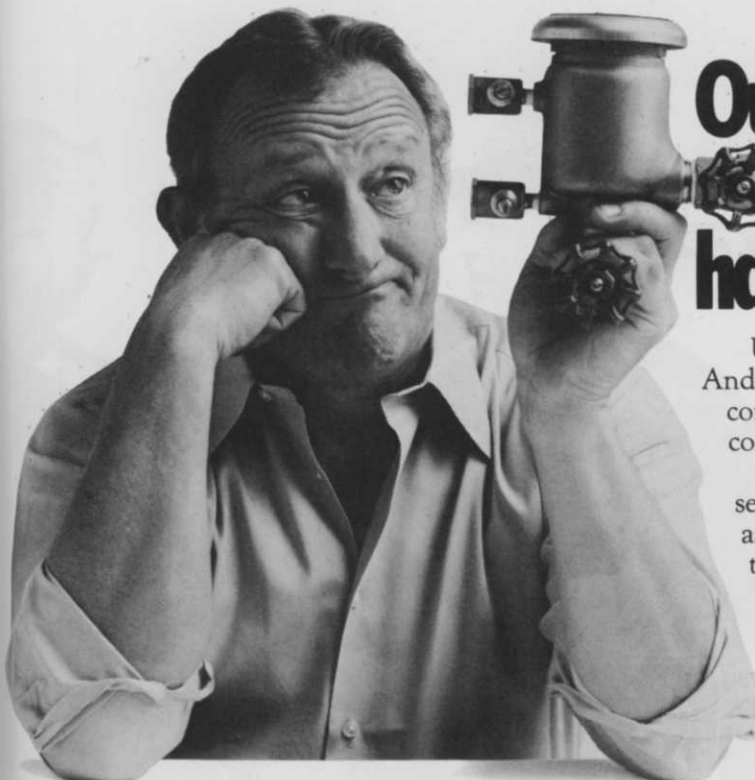
When the valve is electrically energized by the controller, the motor extends the shaft forcing the seating disc away from the body seat, opening the valve.

When the controller "station" is de-energized, the valve spring forces the seating disc against the body seat, closing the valve.

**Normally-Closed.** Electric remote control valves are a "normally-closed" type. This definition means that should the electricity to the valve be interrupted for any reason, such as a power failure, broken wire, etc., the valve will automatically close itself. This feature is of considerable importance.

**HYDRAULIC AUTOMATIC SYSTEMS.** Turf sprinkler systems using water as the "actuator" for remote valves are classified as "hydraulic automatics." Hydraulic controllers apply or release water pressure through "hydraulic tubing" to the hydraulic remote valves. There is more than one method by which the controller operates remote valves. However, since all are quite similar only the most commonly used method is outlined in detail.

**tubing.** Pressurized water is brought into the controller by a tube connected to the "main" pressure pipeline of the sprinkler system. This tube must be connected to the "main" in front of all remote valves. Occasionally, an independent water source



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with pressure as great or greater than that in the system is used.

Water pressure is applied, or released, through tubes connected between the controller and the remote valves. The individual "stations" control this function with a special "selector" valve; or with a bank of individual small, electric solenoid valves commonly referred to as "pilot" valves.

As shown in Figure 15, a separate control tube is required for each "station" to operate its valve or valves. Control tubing, often referred to as "hydraulic" tubing, is usually small — 1/4 or 3/8 inch nominal size — and flexible soft-annealed copper or plastic. Always check equipment manufacturer's recommendations for size. Also, larger tube may be required when one tube controls more than one valve.

**Operation.** In the non-operating position, pressurized water from the supply fills the supply tube and valve tubes through the open selector valve or the individual, 3-way solenoid pilot valves. This pressure forces the diaphragm (or piston) seating disc down and against the body seat, holding the valve closed. (Figure 14, closed position).

When a controller "station" activates the selector valve, the water supply to the remote valve controlled by that "station" is shut off and pressure in its control tube is relieved through a drain tube. (Figure 16, open position.) Relieving pressure in the control tube also relieves pressure in the upper

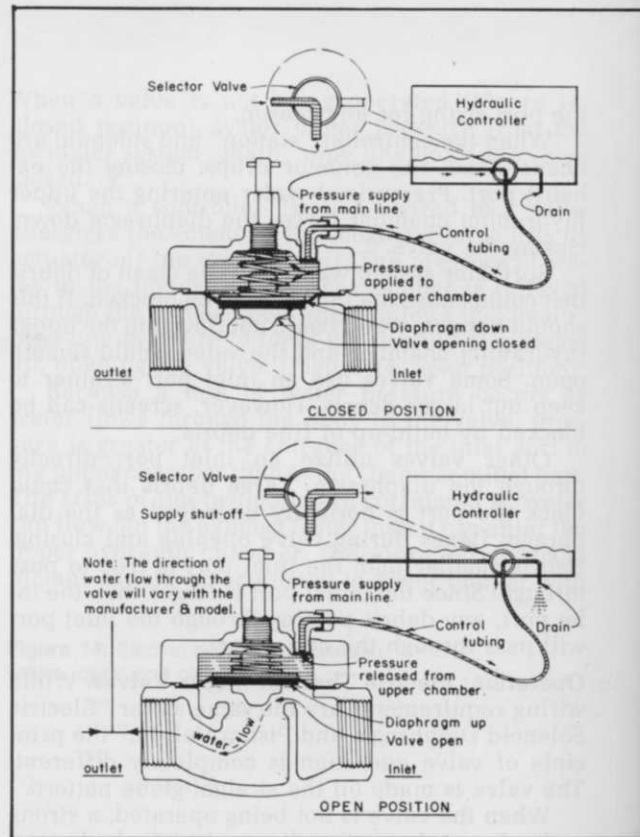
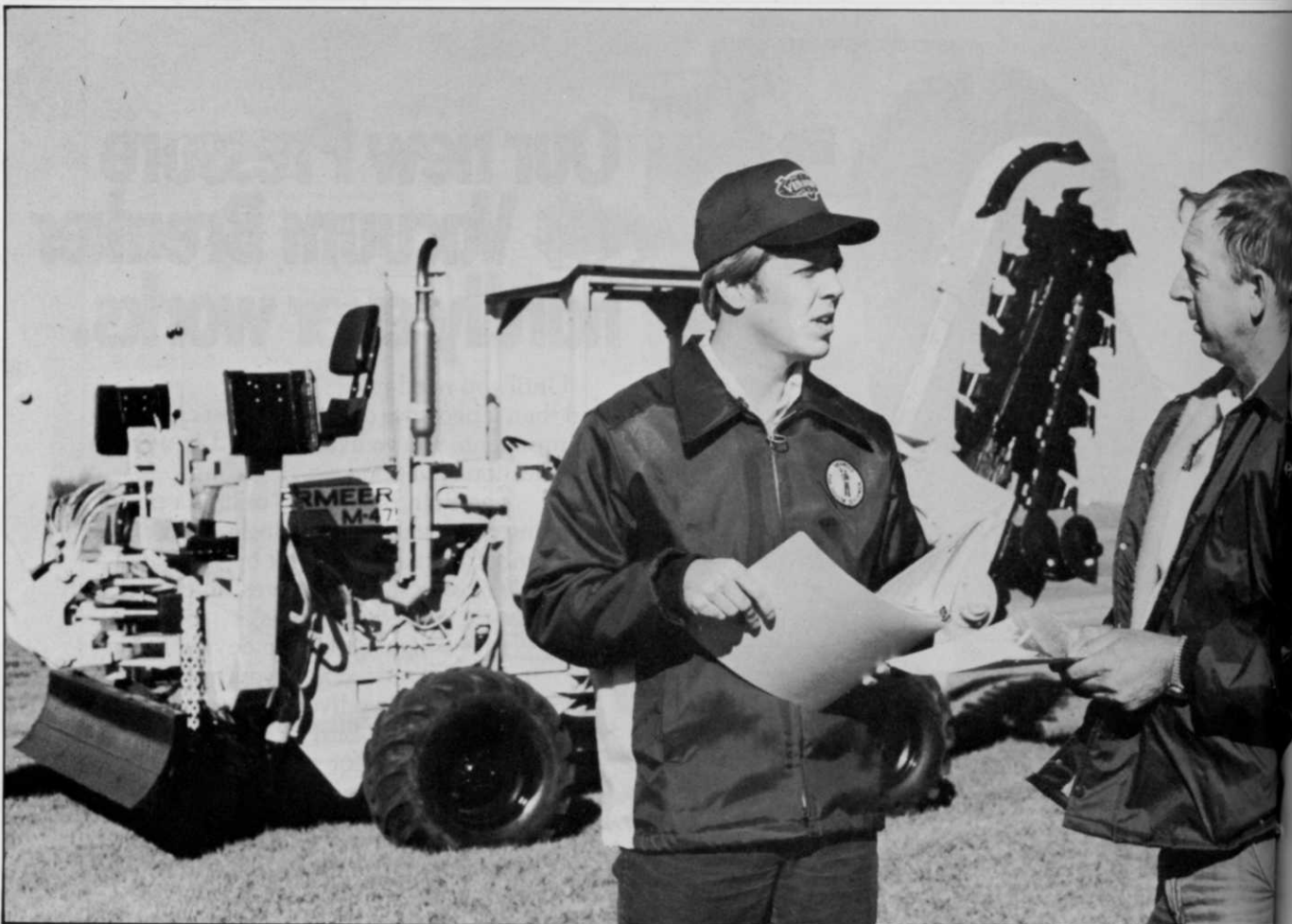


Figure 16: Hydraulic diaphragm valve, open and closed.





(hydraulic) chamber of the remote valve. Pressure in the sprinkler system main supply pipe forces the diaphragm (or piston) up, opening the remote valve.

When that "station" is de-activated, the process is reversed and pressure in the control tube forces the diaphragm (or piston) down, closing the valve. (Figure 16, closed position).

**Alternate Method of Operation.** In one of the other methods of hydraulic automatic systems operation, the pressurized water (from the upstream sprinkler main line) required to close remote valves enters the upper hydraulic chamber of the valve through an internal port. These inlet ports are located exactly the same as those in electric diaphragm valves; either through the valve body or the diaphragm. In piston valves, the port is through the center of the piston.

To operate, two-way selector or pilot valves are used to relieve the pressure in the upper (hydraulic) chamber. This allows the system pressure to force up the diaphragm (or piston), opening the valve. During system operation, there is a constant small bleed of water through the common drain tube of the controller. This bleed tube is commonly serrated every few inches and buried in a shrubby bed. It can also be connected to a shrub head, if desired.

When the pilot valve in the controller closes,

water pressure again builds up in the upper (hydraulic) chamber of the valve, closing it.

**Clean Control Water.** The water used to operate remote valves in a hydraulic system must be clean. Most manufacturers specify that a strainer be installed in the supply tube to the controller to avoid clogging of the pilot valve (or valves). Such clogging can prevent the supply of pressurized water to the remote valves, in which case they would not close.

**Controller Freeze Protection.** Hydraulic controllers must be protected against any freezing, if the control tube and/or valves are located in the controller. Also, when the earth freezes to the depth of buried tubing, all tubing must be drained. The small control tubing cannot be drained with the normal methods of draining system piping. The only successful way of removing water from the control tubes is to blow it out with an air compressor.

**Special Note.** Unlike electric automatic systems, when the "actuator" source to the hydraulic remote valves — pressurized water — is interrupted, the remote valves will open and remain open until pressure is returned. Such failure can be caused by a leak occurring in the control tube, a break in the tube, or a clogged or malfunctioning pilot valve.

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