SPRINKLER EQUIPMENT FROM IRRIGATION MANUAL

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Sprinkler systems for turfgrass and landscaping are classified under three basic types characterized by the kind of equipment utilized:

(1) Spray Systems
(2) Rotary Systems
(3) Quick-Coupling Systems

The cost of the three types of systems is in an approximate ratio of 4 - 2 - 1; spray systems being the most expensive, rotary systems intermediate, and quick-coupling systems the lowest in cost. Thus, a spray system will cost about four times as much as a quick-coupling system, or twice as much as a rotary system; a rotary system will cost about twice as much as a quick-coupling system. Furthermore, each system will fall within a high and low price range of its own due to variations in quality of equipment, piping material selected and the type of property to be watered.

An intelligent selection cannot be based on the relative prices of the three systems alone. For example, a rotary system may meet a budgetary requirement, yet prove totally inadequate for the size and shape of the property or the watering conditions. Application of the three systems overlaps to a great extent, but their adaptability does impose some limitations as to size and nature of the project for which each is best suited.

Before going into the many aspects of sprinkler system design, it is only appropriate that application, relative merits and components be considered first.

SPRAY SYSTEMS

The versatility of spray systems accounts for their extensive use for all types of properties. In spite of their higher cost, spray systems are the most popular because they offer the ultimate in automation, efficiency, convenience, labor savings and aesthetic value.

There are no fixed limitations on the size of project to which spray systems may be adapted, except those imposed by economics.

The sprinkler heads used in this type system discharge a fine, uniform spray. These sprinklers are sometimes referred to as "mist" heads, but this is a misnomer because the spray more nearly resembles small rain-drops.

The following article is an excerpt from the Sprinkler Equipment chapter of the TURF IRRIGATION MANUAL by James A. Watkins and is reprinted with permission of the author and the publisher, Telsco Industries. Other chapters of the TURF IRRIGATION MANUAL include Piping, Hydraulics, Water Hammer, Cross-Connection Control, Pumps, Clean Water, Sprinkler Performance, Plot Plans, Head Layout, Pipe Sizing and Zoning, Rotary System Design, Golf Course System Design and Electrical. In addition, the book has 60 pages of design reference tables.

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Use of the term, "mist head," stems from the characteristics of the spray. The correct amount of water pressure at the sprinkler will form fine water droplets resembling "mist" floating above the spray. Lack of any "floating spray" indicates pressure to the head is below the required amount. In such cases, the coverage is probably deficient. Conversely, abnormally high head pressure causes an excessive amount of "floating spray" which will blow away and increase water costs.

Sprinkler systems of all types with low pressure, and sometimes with excessive pressure, are the direct result of poor system design.

Spray Heads

An exemplary layout of a residential spray system is shown in Figure 1. It illustrates the wide variety of heads in different capacities, spacings and coverage patterns required to provide complete and uniform watering.

POP-UP HEADS. Spray heads for installation in lawns are pop-up types, often referred to as "lawn heads." These heads are installed flush with the turf. A nozzle pops-up to deliver the spray during operation and recedes within the body when inoperative.

Nozzles. The normal area of coverage for pop-up spray nozzles varies from 16 to 30 feet in diameter, in increments of one or two feet, depending on the nozzle or orifice size. Available increments may be more than two feet for large diameter sprays. Shorter radii are available in part circle. Heads are spaced at close intervals (generally 10 to 24 feet apart after making allowances for the required overlap).

Spray nozzles are available in a wide assortment of part-circle patterns. The usual assortment of arcs ranges from ¼ circle to ¾ circle in increments of ⅛ or 1/3. Special arcs for custom system design situations are usually available in 10° increments from 60° to 270°.

Orifices of nozzles are sized to provide a specified radius of coverage and flow at a specified pressure. The specified pressure must be provided by the system designer to obtain proper coverage. If pressure is too low, the spray will not "break-up" into the required fine water droplets

Spray system heads discharge a fine, uniform spray. The correct amount of pressure will cause the appearance of a mist floating above the spray.

necessary to give proper distribution to the entire radius. Also, the specified radius will probably not be attained.

Adjustable full and part-circle nozzle's are also available to the designer. These nozzles feature an adjustment screw for regulating the spray radius. Adjustable nozzles normally are not available in coverage arcs considered special.

Many designers prefer the "fixed-orifice" or non-adjustable nozzle. Pipe-sizing is used to control volume and pressure to the heads. This method insures a "designed-in" balance of sprays throughout the system. This balance is maintained since unknowing persons can't change the flow characteristics of the nozzles with a screwdriver.

Spacing. Head spacings are a matter of choice, Although 20 foot triangular spacing has become more or less standard throughout the industry. There are occasions when a low static pressure or small water supply requires the use of closer spacing.

Each manufacturer provides spray nozzle performance tables indicating water pressure and flow required to obtain coverage. The specifications or tables will also recommend maximum head spacing. Maximum spacing is the distance the heads can be placed apart and still provide the necessary overlap of sprays required for good distribution. Spacing recommendations should never be exceeded. Also, it is cautioned that performance will vary from one manufacturer to another.

Construction. Although there are various popup spray head designs, only that configuration considered *standard* is discussed in this text. The *standard* head has a nozzle flange which seats into the body; see Figure 2. This type construction usually prevents dirt from falling into the head between the nozzle assembly and the body barrel. If dirt enters the head at this point, the pop-up action may be affected, and the resulting malfunction creates unnecessary service problems.

A well designed sprinkler head does not sacrifice material for economy at the expense of performance. There are certain minimum standards that should be met in product design.

The nozzle assembly (functional parts) must contain sufficient weight and clearance within the barrel of the body if it is to recede properly. Otherwise, the advantage of the pop-up is lost in failure

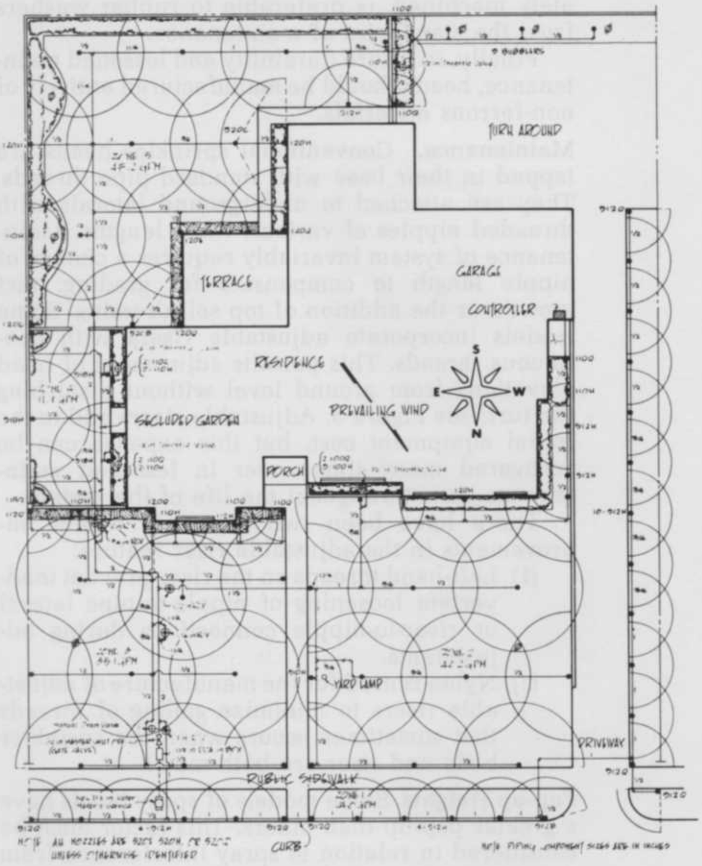


Figure 1: A layout of a residential spray system showing a variety of coverage patterns.

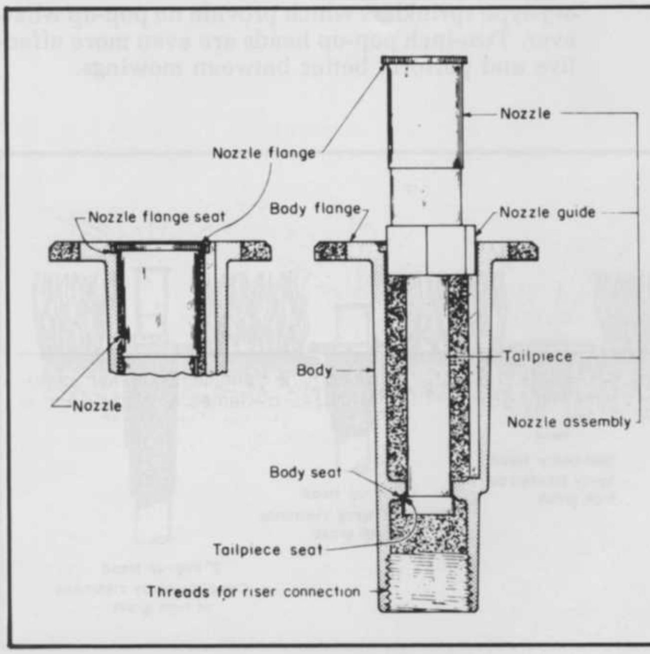


Figure 2: The standard pop-up spray head consists of a nozzle flange which seats into a body.

to retract. Tailpieces should have an adequate cross-sectional area for passage of water to avoid a high pressure loss through it. If it does not, the head will require an abnormally high inlet pressure.

Direct body-to-tailpiece "seating," if accurately machined, is preferable to rubber washers from the standpoint of maintenance.

Finally, to insure durability and lessened maintenance, heads should be manufactured entirely of non-ferrous materials.

Maintenance. Conventional sprinkler heads are tapped in their base with standard pipe threads. They are attached to underground laterals with threaded nipples of various, fixed lengths. Maintenance of system invariably requires a change of nipple length to compensate for grading, turf growth, or the addition of top soil dressing. Some models incorporate adjustable risers with continuous threads. This permits adjustment of head elevations from ground level without disturbing the turf; see Figure 3. Adjustable risers add to the initial equipment cost, but this expense can be recovered many times over in lessened maintenance costs throughout the life of the system.

There have been two relatively recent improvements in the adjustable riser feature:

(1) Left-hand threads on the riser prevent inadvertent loosening of nipple-to-pipe lateral or riser-to-nipple connections during adjustments.

(2) Nylon is used for the manufacture of adjustable risers to minimize galling of threads that sometimes occurs when the sprinkler body and riser are both metal.

Pop-up Heights. Some models of spray heads have a greater pop-up than others. This factor must be considered in relation to spray interference from the grass.

The pop-up should not be less than one inch, as shown in Figure 4. Otherwise, the sprinkler would have no advantage over the obsolescent, stationary-type sprinklers which provide no pop-up whatever. Two-inch pop-up heads are even more effective and perform better between mowings.

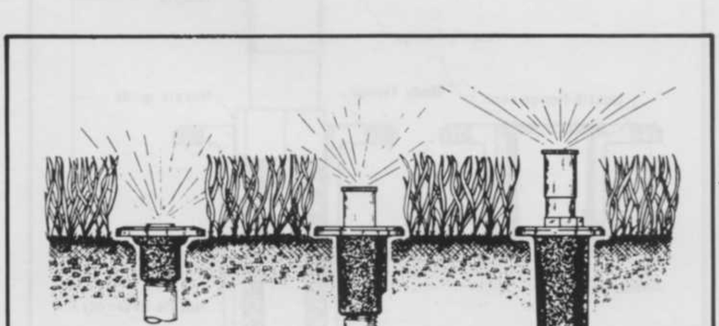


Figure 4: Pop-up height should be considered in relation to spray interference from the grass.

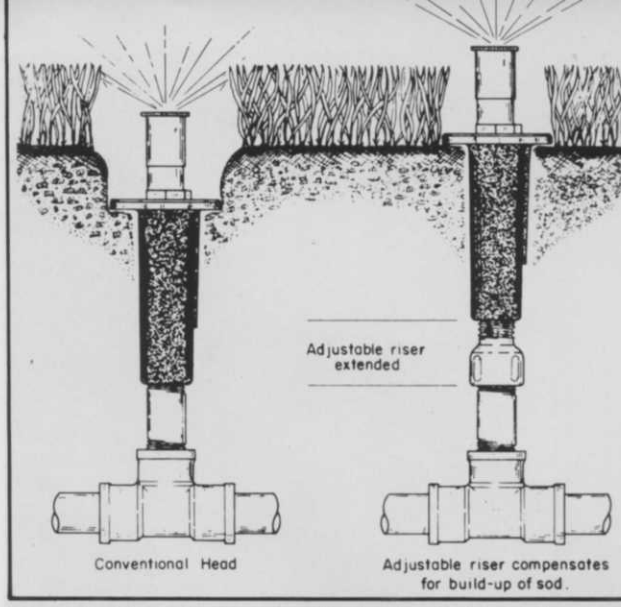


Figure 3: Adjustable risers permit adjustment of head elevation without disturbing the turf.

SHRUB HEADS. Spray heads designed for installation in or above shrubbery and flowers deliver water exactly the same as pop-up sprays. However, shrub heads are made to a much smaller configuration for aesthetic purposes.

Compatibility. The spray of shrub heads should be exactly compatible with pop-up head sprays. This is important because a great percentage of shrubbery can be sprinkled with the same amount of water required for the lawn areas. In these cases, system design can be simplified by blending the sprays of both type heads and operating them together. When systems can be designed this way, unnecessary costs for extra valved zones are avoided.

SPECIAL SPRAYS. A wide choice of spray nozzles and heads with special features is available to the designer.

Low Angle Sprays. Normal spray trajectory is about 30° to 40° above horizontal. Part circle sprays, for both pop-up and shrub heads, are available with a low-angle trajectory of about 10°. The low trajectory reduces the adverse effect of wind drift.

The low-angle shrub spray has proven to be especially beneficial. In fact, most systems installed to day use this feature. Shrub heads should never be installed more than 4 feet above grade in order to assure coverage under the head.

Part-circle, low-angle spray nozzles are sometimes used in pop-up heads. For example, alongside heavily-trafficked sidewalks to minimize the blowing of spray onto the pavement.

Strip Sprays. Spray nozzles for watering long, narrow strips of turf or plantings are available in several different types. These sprays, sometimes called "line" sprays, are generally designed to water 1 to 3 foot wide strips.

Stream Sprays. Some manufacturers offer a spray nozzle that disperses water over the rated coverage area with tiny streams. Generally, it is recommended that heads using stream nozzles be spaced so that streams from each head overlap adjacent heads. With such spacing the streams adequately "crosscross" to provide coverage between the streams. See Figure 5.

Sprinkler *from page 26*

Because of their low volume of discharge (and consequent lower rate of precipitation) the stream nozzles are often used on non-sodded banks and berms to minimize run-off and "wash." Also, they are sometimes used in rotary systems to water isolated areas. Because their precipitation rate is closer to that of rotary sprinklers than regular spray heads, they are often operated with the same zone valve.

Because of the very small orifices which form the streams, very clean water is required to avoid an abnormal amount of maintenance to keep these orifices clean.

SPECIAL SHRUB NOZZLES AND HEADS. To further aid the designer, a number of special purpose shrub heads are available.

Short Radii Nozzles. One widely used head is a partcircle spray which features (1) an extremely small radius of about 3 feet, (2) a relatively flat trajectory and (3) low water flow consumption. It can be used for watering "from above" in the normal manner; more often it is used for "flood watering" of narrow, confined areas such as planter boxes. Full-circle sprays available offer a minimum radius of about 6 feet. Head selection will range upward to coverages and flows similar to those available for regular spray heads.Designers may also choose trajectories from "below horizontal" to normal (30° to 40°), depending on model.

Deep Watering. Special heads are required for deep watering of individual shrubs or trees.

One type of special head for this purpose is known as a "Bubbler." It discharges water with an "oozing" effect and is adjustable from very low flows to relatively high flows.

Another type disperses water with small streams. These heads are known to the trade by such names as "spider" and "Jet Irrigator." At low

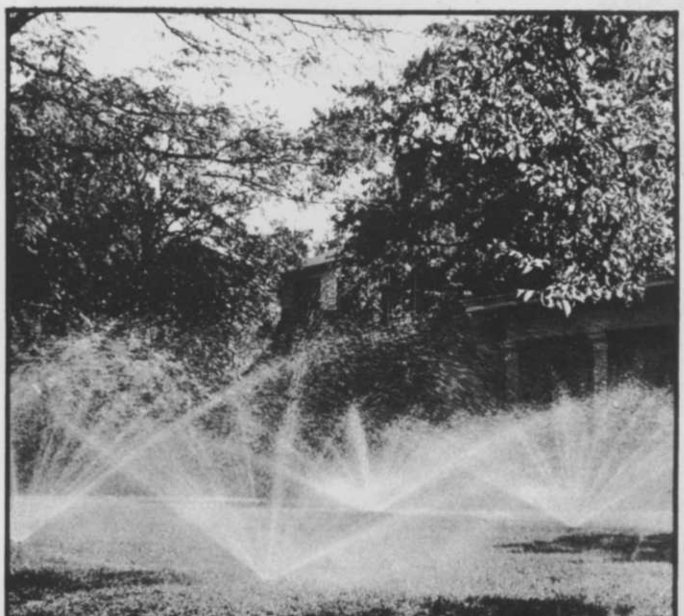


Figure 5: Stream spray nozzles should be spaced so that streams from one head overlap adjacent heads.

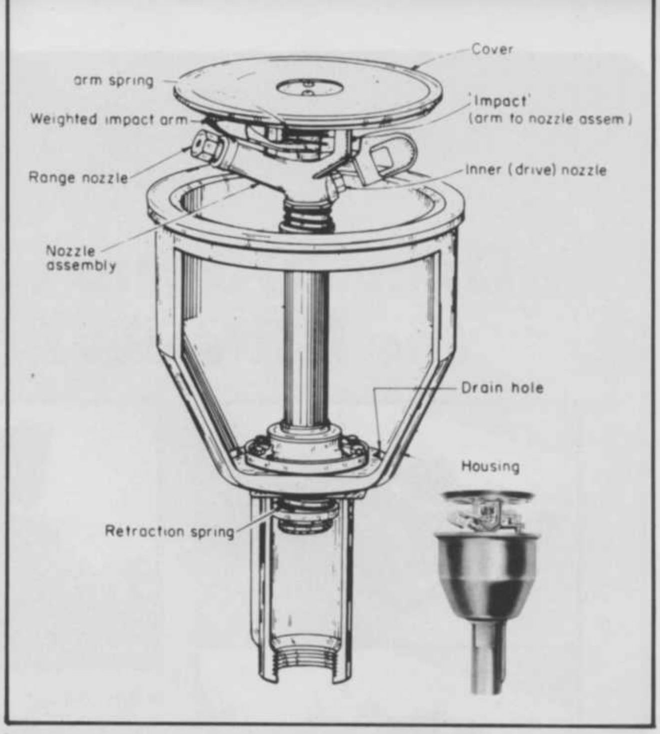


Figure 6: Impact drive rotary sprinklers are rotated by water impacting against a spring-loaded drive arm.

adjustment, the streams reach out only a foot or two, providing an extremely slow soaking action for close-located shrubs. At full-open, the adjustment provides slow precipitation to areas 6 to 8 feet diameter. These heads are available in both full-circle and part-circle models.

Nozzle Adapters. For design versatility, most manufacturers also provide special adapters for compact shrub-mounting of pop-up head nozzles. One pop-up nozzle commonly used in this manner is the "strip" or "line" spray nozzle described previously. This nozzle is excellent for watering narrow planting beds from "above."

EFFICIENCY. Spray systems precipitate water rapidly, at the rate of about one inch per hour; distribution is considered exceptionally uniform when system is properly designed. Since the rate of application is much greater than for other types of systems, the watering schedule can be accomplished in a much shorter period of time. And, since evaporational loss is in direct proportion to the length of operation time, spray systems unquestionably use less water. Automation can help reduce evaporation loss still further by facilitating watering at night. The percentage of water loss due to evaporation is considerably higher for daytime operation.

Watering at night should occur as near to dawn as possible for best results. Avoid evening watering if possible. When watering is done in the evening, the earth remains wet all night. And, overnight dampness provides ideal conditions for growth of moss, fungus, etc.

DESIGN CONSIDERATIONS. Spray systems are zoned and operated in sections or circuits sized to fit the existing water supply, or a new, larger service, if required. The number of heads per circuit is dependent on the flow requirements of each, and the capacity and pressure of the water supply. Thus, the smaller water supply will always necessitate more zones, or circuits, and increase the length of the watering cycle.

Ordinarily, it is impractical to operate all sprinklers in a system simultaneously. The combined flow might create too great a load on the city water main, or the cost of a large enough water service and meter might be prohibitive. On the other hand, too many circuits will prolong the length of watering time beyond reasonable limits. Therefore, if full utility of the system is to be realized, an adequate water supply must be provided in proportion to the property size.

COST FACTORS. The cost of a spray system will vary considerably with such factors as type of equipment, kind of piping, regional labor rates, quality of system design, etc. Due to the many variables, there is no single yardstick that can be applied to cost estimations. For example, a corner lot will cost more than an inside lot of the same size because a greater number of part-circle sprinklers will be needed for perimeter watering.

Part-circle spray heads cost approximately the same amount as full-circles, installed. Therefore, a ½-circle spray head will cost twice as much as a full-circle in relation to the amount of area watered. A ¼-circle would cost four times as much, etc.

Pipe and fittings, which serve as a framework for the system, and labor comprise about 65% of the overall cost. Labor is largely a fixed cost (subject only to the economies that may be realized from efficiency and mechanization). The cost of pipe and fittings will naturally change with the grade of material specified.

The remaining 35% of the cost is made up of sprinkler equipment consisting of heads, control valves, automatic controllers and accessories. Trying to seek savings on sprinkler equipment can very well lead to false economy when realizing that the cheapest equipment can be expected to meet minimum standards of performance, at best. On the other hand, the finest equipment obtainable adds only a nominal amount to the initial cost while offering optimum results with less maintenance expense.

ROTARY SYSTEMS

Because of their intermediate cost, rotary systems are quite popular for sizeable projects such as large urban home lots and estates, parks, schools, playgrounds, golf courses, public buildings, factories and offices. The area must be large and generally less confined by sidewalks, buildings, etc., since rotary systems are not as flexible as spray systems.

Rotary sprinklers utilize slowly-rotating, high-velocity streams to distribute water over relatively large circular or semi-circular areas. Depending on the model of sprinkler, one to several streams are used. Coverages range from about 40 feet to over 200 feet in diameter.

ROTARY SPRINKLER HEADS

Rotary heads, like spray heads used in turfgrass areas, are pop-up with the head being completely concealed in the ground except for the coverplate, which is exposed at ground level. The nozzle portion pops-up to sprinkle and recedes within the sprinkler housing when inoperative.

During operation, water under pressure flowing through the heads drives any one of several types of mechanisms to rotate the nozzle assembly. Rotary head drives are named to describe the basic component providing the rotational drive force. Most well-known are the "impact" drive and "gear" drive, which are described in the following text along with other mechanism types in use today.

IMPACT DRIVE ROTARY HEADS. The impact drive rotary sprinkler employs a weighted, spring-loaded drive arm to provide the force to rotate the nozzle assembly. The sprinkling stream deflects the arm sideways and the spring pulls the arm back to the nozzle assembly and into the path of the stream. As the drive arm completes each swing cycle it impacts against the nozzle assembly rotating it slightly. See Figure 6. Most models of this type of sprinkler are available in both full-circle and part-circle.

Adjustable arcs. Part-circles are infinitely adjustable for degree of arc to be watered. Adjustment, depending on model, can be as much as from 20° to 340°. Some models are known as "combination" sprinklers because disengagement of the trip-pin of the reversing mechanism converts a part-circle to a full-circle.

Nozzling. Full-circle, pop-up impact sprinklers generally utilize two opposed nozzles; a "range" nozzle and an "inner" nozzle which make possible larger diameters of coverage. Long streams can't provide "breakup" of the stream into the small water droplets required to give distribution for the entire length. So, the "range" nozzle provides distribution at the outer areas of coverage diameter. And, the "inner" nozzle provides the distribution from the head to where the "range" nozzle begins its distribution.

Part-circle impacts also utilize two nozzles. However, the nozzles both face the same direction. Only one nozzle is utilized on some smaller im-

Nozzle	Operating Pressure psi	†Spacing (ft.) Δ	□	Flow gpm	Diameter Coverage ft	Δ ††Precip in/hr
E12 x A11 3/16 x 11/64	50	66	61	12.5	102	.31
	60	68	63	13.8	105	.33
	70	69	64	15.1	107	.35
	80	71	66	16.4	110	.36
	90	72	67	17.8	112	.38
E13 x A11 13/64 x 11/64	50	71	66	15.0	110	.33
	60	73	67	16.4	113	.34
	70	76	70	17.8	117	.34
	80	78	72	19.0	120	.34
	90	79	73	20.2	122	.36
*E14 x A11 7/32 x 11/64	50	74	68	16.2	114	.32
	60	78	72	17.5	120	.32
	70	79	73	18.8	123	.33
	80	81	75	20.1	126	.34
	90	81	75	21.5	126	.36
E16 x A11 1/4 x 11/64	50	75	69	19.0	116	.37
	60	79	73	20.3	122	.37
	70	81	75	21.7	126	.37
	80	83	77	23.0	129	.37
	90	83	77	24.3	129	.39

Table 1. Typical Rotary Sprinkler Performance Table

pact rotaries (both full-circle and part-circle) where the coverage falls within the range of the "inner" nozzles previously described.

Most brands of impact rotary heads are made in several different physical sizes. The nozzles are changeable, thus allowing each model to accommodate several different orifice sizes. It is important to note that while different size nozzles provide varying coverage diameters, each size also requires different water pressures and flow volumes to operate correctly. There is some overlap in the capabilities of various nozzles. Table 1 is a typical data table. It is included to demonstrate the varying performance of nozzles in impact rotary sprinklers.

To accomplish the distribution pattern with two-nozzle sprinklers the manufacturer determines the best combination of nozzles.

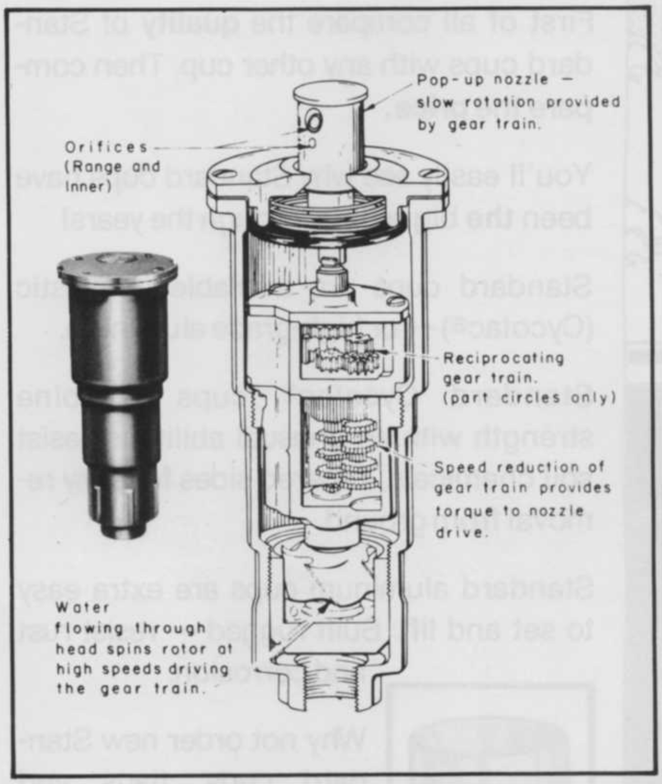


Figure 7: Gear-Drive heads provide a steady rotation and good coverage.

Caution should be used when changing nozzles in the field. Incorrect nozzle combinations will upset the distribution, resulting in areas with deficient coverage. Some nozzles are available with an adjustable "diffuser-pin" to provide a means of changing the distribution and coverage within reasonable limits. Two other cautions should be noted: (1) Use nozzle sizes for which water pressure and flow volume can be supplied according to the recommendations of the manufacturer. (2) Design in accordance with performance table minimum *and* maximum pressures beyond which a nozzle should not be used.

GEAR-DRIVE HEADS. Gear drive rotary heads provide a steady, powerful rotation to the sprinkling streams. Water under pressure enters the base of the head through a diffuser which converts it into high velocity jets. These jets are then impinged against a turbine-like rotor causing it to spin extremely high speeds. A gear train, driven by the rotor, reduces the high rotational speed and converts it into a powerful turning torque. This torque gives the nozzle-assembly the relative slow rotational speed required for good coverage and precipitation. See Figure 7.

Part-circle reversing. The part-circle models incorporate a gear reciprocating mechanism that slowly drives the nozzle-assembly back and forth over a predetermined arc. Gear trains are usually contained in separate housings to protect the gears from debris in the water.

Nozzling. The distribution pattern of Gear-Drive rotary sprinklers is accomplished much the same as it is with the Impact-Drive type. Some models use interchangeable nozzles. Again, the user is cautioned not to upset distribution with improper combinations.

Another method of forming the high-velocity watering streams is the use of a nozzle similar to the Spray Head nozzle but with orifices fixed into it. However, the nozzle can be easily replaced by another with different orifices to obtain different

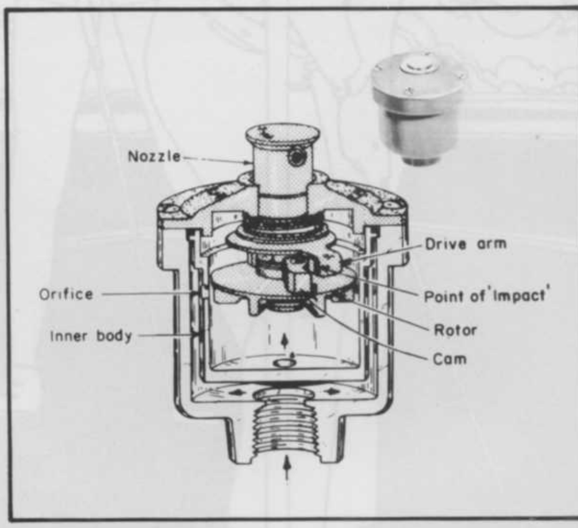


Figure 8: Cam-Drive rotary heads have a continuous rotation for all practical purposes.

coverages. Generally, the orifices for full-circle coverage are opposed. When two orifices are used for part-circle coverage, they are placed one above the other.

OTHER DRIVE TYPES. The most common rotary head drives, other than the two preceding, are the "Cam-Drive" and "Ball-Drive."

Cam-Drive Rotaries. Figure 8 illustrates a rotary sprinkler employing cams mounted directly on a rotor. Jet-streams, formed by water under pressure passing through orifices in an inner body, impinge against the rotor spinning it at high speed. As the rotor spins, the cams are swung outward by centrifugal force. On each rotation of the rotor, the cams strike a drive arm attached to the nozzle, causing a slight rotation. Upon impact, the cams swing inward instantaneously to pass the drive arm. Because of the high speed of rotor rotation and the number of cams, nozzle rotation is continuous for all practical purposes.

Ball-Drive Rotaries. Figure 9 illustrates a sprinkler utilizing a spinning metal ball to provide the power to rotate the nozzle. Water under pressure enters the head through a plate with angular openings located in the base of the head. This action causes the water to spin at high circular velocity.

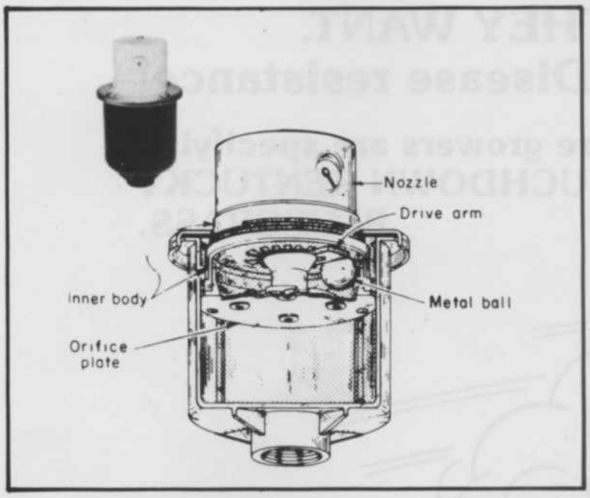


Figure 9: Ball-drive rotary sprinklers provide a slow steady rotation.

This circular flow causes a free metal ball to spin up and around the top inside of the body. As the ball spins, it strikes a projecting drive arm attached to the nozzle. Each impact rotates the nozzle slightly. The impacts occur so rapidly that, in effect, a slow, steady, rotation is seemingly accomplished.

Part-circles. Many cam and ball-drive sprinklers employ a hood over and around the nozzle to provide part-circle coverage. The hood has a milled-opening on one side corresponding to the arc of coverage. During nozzle rotation, the sprinkling streams are "blocked-out" as they enter the unmilled portion of the hood. The running clearance between the hood and nozzle can cause some degree of puddling near the head.

EFFICIENCY. The water distribution of rotary systems is not as good as with spray systems because even the slightest breeze will bend or whip the long streams. For this reason, additional compensation must be made for the velocity and direction of the prevailing wind in each locale. Since this condition becomes more acute with the longer range heads, the trend is toward closer spacing and shorter throw.

Most designers, today, agree that 65 ft to 75 ft spacing is the most effective and economical for large areas; even for golf course. Aside from better performance, as compared to larger spacings requiring greater diameters of coverage, these medium spacings offer some cost advantage. The decreased flow and pressure requirements for smaller heads permit smaller piping and greater zone flows. An added advantage is that the smaller coverage heads have a slower precipitation rate.

Since the precipitation rate of rotary systems averages only 1/5 to 1/3 of spray systems, the time required to provide the same amount of irrigation will average about four times longer.

The longer watering schedule and resultant evaporation losses associated with slower precipitation, plus a less even distribution of moisture, would seem to make rotary systems somewhat less desirable. However, the economy to be realized on projects involving acreage minimizes these deficiencies to a large extent. Other factors also minimize these deficiencies: (1) night watering reduces evaporation, and (2) effects of wind on coverage are reduced with longer watering periods because, in most locales, wind varies in velocity and direction constantly.

Christian, in his bulletin on extensive research of impact rotary sprinkler precipitation, reported that these sprinklers are subject to uneven distribution due to variations in speed of rotation. Since rotation variation increases with wear, and does not become visible to the eye until the turf shows uneven distribution, maintenance programs should include a rotation check every year or two.

DESIGN CONSIDERATIONS

Rotary Sprinkler Selection. A careful choice of make and model is vital to a good, economical rotary system design.

Factors to be considered before selection of rotary heads include the area to be sprinkled; available water volume and pressure. There are rotary heads available for almost every type of situation. For example: rotary heads specifically designed for use in larger plots with small water supply. These heads can be spaced about twice as far apart as spray heads, but have a smaller flow than some spray heads. On the other hand, these rotary heads should never be used on large areas with high pressures.

Conversely, use of large-coverage rotaries in areas that are more suitable for use of the smaller coverage heads, even though the water supply is adequate, will result in a totally undesirable system. With bordered areas, due to overlap required, water waste usually increases as the sprinkler diameter of coverage increases.

Zoning. Pop-up rotary systems, like spray systems, are valved and operated in zones, or sections. This procedure avoids overloading the water supply. Again, the number of heads in each zone depends on the volume of water available and the pressure.

Precipitation. The full and part-circle rotary heads of many models are not balanced to provide uniform rates of precipitation. For example, some have the same nozzle orifices for full and fractional circles. Consequently, quarter-circle heads will apply twice as much water as half-circles and four times as much as the circular ones; half-circles will apply twice as much as circular heads. Obviously, each type (full, halves and quarters) must be valved separately from the other types in this case. Otherwise, certain areas will have to be flooded in order to apply enough precipitation elsewhere.

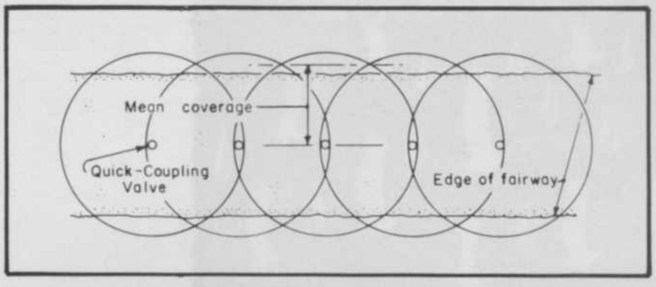
Needless separate valving poses a problem for the designer and adds considerably to the cost of labor and material. Heads that are compatible precipitation-wise may be valved together, making a more compact system at substantial savings.

Because of the character of impact rotary sprinklers, the precipitation rates of full and part-circle models are seldom, if ever, compatible for any given radius of coverage. Therefore, full-circles, part-circles averaging 180°, and those close to 90° should generally be valved separately.

Many models of rotary sprinklers, other than the impact-drive, are available with precipitation rates of full and part-circles compatible to the extent that they may be valved together. However, their areas of coverage are usually limited as compared to the impact sprinklers.

Compatibility of precipitation cannot always be determined by comparing flows. For example: at least one gear-driven rotary has a "dwell" at each end of the coverage arc built in the head. This "dwell," of several seconds, provides needed additional watering at the edges of the coverage pattern to help offset the effects of wind. This additional "edge-watering" causes the flow rate of a half-circle to be about more than one-half the flow rate of the full-circle. However, tests show that the precipitation over the watered area is compatible.

Gear-drive heads which provide a "dwell" at each end of the coverage arc, and compatibility of precipitation and pressure requirements between full and part-circle models, are favored for irrigating parks, school grounds, etc. This is particularly true when pressure requirements of the sprinklers enable operation with city water supply without the need of booster pumps.



Quick-coupling systems in fairways should be spaced to spray head to head for adequate coverage.

Caution. Before valving different types of sprinklers together, consider pressure requirements in addition to precipitation rates. For example: even though two sprinklers have the same precipitation rate, one may require 35 lb/in^2 water pressure at the base of the head while the other requires 60 lb/in^2. Obviously, a piping system cannot be designed to handle this disparity.

Spacings. Coverage ratings and spacing are generally given for still air which must be derated to compensate for prevailing winds in the locale of the system. A *standard formula for spacing deration is not feasible because of the varying stream characteristics of different sprinklers.* Use recommendations provided by each manufacturer for his equipment.

SPECIAL CONSIDERATIONS. As previously pointed out, the long streams of rotary sprinklers are affected by wind; even moderate wind. Prevailing winds and site conditions should be carefully considered when designing a rotary system. Care should be exercised that sprinklers are located so that the streams will not blow onto areas where such watering would be objectionable.

This same concern should be considered when using the impact drive sprinkler. As the impact-drive arm swings, it passes through the high-velocity stream twice on each cycle, causing some degree of "back-splash." With part-circle sprinklers of this type, the "splash" might be objectionable if placement of the sprinklers is not weighed carefully. Some heads of this type are available with anti-back-splash devices which help.

It should be noted that with rotary systems, there are almost always some relatively confined areas that must be watered with spray sprinklers. The spray sprinklers must be operated independently from the rotary sprinklers because of the large variance in precipitation rates of the two types of sprinklers; on an average, four to one.

COST FACTORS

The cost of a rotary system will average 50 to 70 percent of the cost of a spray system in the same property. The differential between the two systems tends to diminish with a reduction of area, and increases as the sprinkled area becomes larger. The principal reason for this is that the ratio of part-circle to full-circle heads increases as the property becomes smaller, requiring more perimeter watering.

Unlike spray heads, the unit material cost for part-circle rotary heads is somewhat greater than for circular ones; however, the area of coverage is only one half as large in the case of half heads and one-fourth as large for quarter heads. Therefore, the cost per square foot of coverage is considerably more than two times greater for half heads and four times for quarter heads. These ratios may vary with model.

QUICK-COUPLING SYSTEMS

While the least expensive quick-coupling systems are no longer being installed to any extent. In the past, they have been used primarily in golf courses, large parks and other extremely large properties, when lowest initial cost was the principal consideration. Many of these systems, particularly in golf courses, are being converted to automatic rotary systems.

However, the components of these systems are still used frequently in conjunction with spray or rotary systems.

(1) As a temporary means of watering areas in which it is not economical to install a regular system; such as areas to be redeveloped at a later date, etc.

(2) On pressure mains of a system to provide water for a myriad of uses other than normal sprinkling. For instance, deep-watering newly-planted trees.

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Sprinkler *from page 36*

COMPONENTS

Equipment for these systems consists of above-ground rotary sprinklers, quick-couplers, and quick-coupling valves. These components, together with a simple system of piping, comprise the cheapest watering system that can be installed.

ABOVE-GROUND SPRINKLERS. Most of these sprinklers are of the basic impact type with a swinging drive-arm. In one variation, the drive arm swings vertically instead of horizontally. Principle of operation is as described for impact drive, pop-up rotary sprinklers which are an adaptation of the above ground sprinkler.

QUICK-COUPLING VALVES. The valve is used to connect the above-ground rotary sprinkler to the water piping. These valves are installed flush with the turf, the same as sprinkler heads.

In the normal method of use, water pressure is maintained continuously at the Quick-Coupling Valve. Water pressure and a spring hold the valve closed when not in use.

METHOD OF OPERATION. The above-ground sprinkler is connected to a Coupler. The coupler is screwed into the valve, forcing the seat down and open. This allows water to flow through the coupler and sprinkler.

On smaller, more compact installations, it is customary to design the system so that sprinklers can be attached to successive quick-coupling valves for the sake of convenience. On larger projects, the system is usually planned for connecting sprinklers at alternate valves for each operation; or every third valve, or even alternate rows in some cases. Golf courses using the larger coverage diameter heads of 150 feet, 200 feet, or even more, commonly operate one sprinkler per fairway.

With operation as outlined in the preceding paragraph, the flow of water is quite well dispersed throughout the system. Spreading out the water load in this manner will permit reduction of pipe sizes, providing initial cost savings without affecting performance. However, some additional cost of moving sprinklers around will be incurred.

EFFICIENCY

Although quick-coupling systems have the lowest initial cost, there are other cost factors that must be considered. Generally, sprinklers with larger diameters of coverage are used with these systems. Greater overlap must be provided, and the longer streams are more subject to wind drift. Both of these factors result in wasted water.

A second major factor in the decline in use of quick coupling systems is the high cost of hand labor. Labor to operate these systems is a continuous expense. Elimination of this expense is a primary reason for increased popularity of automatic rotary systems.

DESIGN CONSIDERATIONS

Watering is accomplished by individually plugging the sprinkler-coupler combination into the quick-coupling valve. Sprinklers are left in place until the desired amount of precipitation is attained, then the sprinklers are removed and coupled to another set of valves, usually adjacent to the area just watered. Sprinklers are moved about in this manner until all areas have been watered. Sprinkler rotation is slow enough to enable the operator to plug-in and remove sprinklers without getting wet.

The above-ground sprinklers are available with diameters of coverage similar to those of pop-up rotary sprinklers. In addition, a number of models have a significantly greater range of throw. Spacings must be derated to compensate for wind.

An exception to the above is golf course systems designed with a single row of very large coverage diameter sprinklers in the center of each fairway. In order to provide adequate mean coverage, golf sprinklers are spaced to throw head-to-head. A common design method is to space quick-coupling valves 85 to 100 feet and use sprinklers with a coverage radius of 90 to 110 feet.

COST FACTORS

Total cost comparison of pop-up rotary vs. quick-coupling systems including (1) amortization of initial cost, (2) operation labor, (3) maintenance, and (4) water usage efficiency, consistently shows that the automatic pop-up rotary system is actually the least expensive over a period of years. **WTT**