some cases low-growing native annual wild flowers can be planted.

In planning for the future development of rough areas two aims should be kept in mind. First, the rough should be developed as an attractive background for the golf holes. A player off his game can at least enjoy the scenery.

The second aim should be the incorporation of plans to make maintenance easier.

Thoughtful consideration and planning with respect to rough maintenance problems can save many hours of labor. There is perhaps no other feature on the golf course where imagination and ingenuity can do so much to improve appearances and to minimize maintenance requirements.

GOLF COURSE IRRIGATION

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It has been said that an irrigation system is only as good as its designer. Never have truer words been spoken. Because each system is an individual problem, one good plan obviously is not suitable to all conditions. An irrigation system must be engineered to conditions of soil, turf, climate, topography, water facilities potential and wind direction, etc. on a specific site. A blueprint design alone is not suitable; there must be a thorough inspection of the course by a competent golf course irrigation engineer. A good deal of money is involved and once a system is installed, it is expected to last, therefore it is important to do it right the first time!

Sources of Information

Where can you go to find the necessary information to do the job right? The Superintendent, the Green Committee Chairman and his committee, the ones who generally spark the project, have numerous sources of information, as follows:

1. Commercial firms that specialize in irrigation equipment and employ irrigation engineers who are available upon request; most advertise in golf periodicals.

2. Private irrigation engineers, independent operators who also advertise in golf periodicals.

3. Golf course architects; they sometimes provide this type service or will arrange for it through local firms.

4. Golf course superintendents and green chairmen who served at the time their system was installed.

5. Articles published in periodicals such as THE GOLF COURSE REPORTER, GOLFDOM, CLUB OPERATIONS, GOLF BUSINESS, the USGA GREEN SECTION RECORD and others.

6. Agencies engaged in the turfgrass field. These include the Golf Course Superintendents Association of America, local Golf Course Superintendents Associations, Agricultural Experiment Stations, State Universities that are engaged in turfgrass research, the National Golf Foundation, the Sprinkler Irrigation Association, the U. S. Department of Agriculture Soil Conservation Division, and the USGA Green Section Regional offices.

Don't hesitate to explore several of these information facets—it could be dangerous to rely upon one source for all your facts.

Sources of Adequate Water

The first step in golf course irrigation study is to find an adequate sup-

ply of water. If no natural ponds, lakes, streams or fresh water rivers are on or near the property, it may be necessary to dig wells or construct a pond or lake. Before any such steps are taken, be sure to check regulations with municipal and state authorities. The use of water is an increasing problem in many areas and where water supply is not now or will not in the future be adequate to meet all needs, it becomes a social, political and economic problem.

Where use of water from streams, lakes or reservoirs is contemplated, the proper federal, state or local officials should be contacted for information regarding permits, riparian rights, apportioning regulations, costs, etc. Sources of water should be thoroughly investigated for contamination or high salt or chemical content which might be injurious to grasses. Water containing high sulphur or other chemical content may have an adverse effect on certain types of valves, pipe or sprinklers.

The amount of water required in any one season will depend on several factors such as geographic location, total rainfall and its distribution, grass variety, type of soil, course topography and length of growing season. A bermudagrass course in Arizona on flat land with sod of a sandy texture obviously will require a greater water supply than a bentgrass course in humid New England on clay soil. A bluegrass-fescue turf on a course in New England on clay soil would require less of a water supply than a bentgrass course in New England. Each special case would require a different total. As a rule of thumb we might consider the following: It is usually said that turfgrasses require one-inch of water per week to thrive. An acre inch of water is equivalent to 27,225 gallons. Therefore, 1,089,000 gallons is required each week of the growing season to irrigate 40 acres of fairway. The total amount and the distribution of rainfall will determine the irrigation pattern, and as the rainfall pattern will vary year to year it is wise to calculate the maximum requirement.

In 1964, the driest year on record since Weather Bureau records have been kept, several 18 hole courses in the Northeast reported they used between 21 and 24 million gallons of water. This was for a six-month period from May through October, the period of severe drought. In a normal season their requirement might be between 15 and 20 million gallons for a four or five month period. To apply these amounts efficiently the output should range between 500 and 800 gallons per minute. Most new installations are aiming at the higher figure.

Types of Pipe

Pipe most widely used to date has been transite (asbestos), or cast iron, or galvanized iron, or plastic pipe or combinations of these. The most recent innovation has been aluminum pipe with a bituminous coating. Each has its own attractive features in strength, longevity, price, and other areas which must be studied with care before a choice is made. For obvious reasons it it important therefore to have expert guidance in choosing the pipe, valves, heads, and fittings for this installation.

The choice of sprinkler heads will depend on the gallon per minute output (nozzle size) and the pressure involved. Firms specializing in the manufacture of heads can supply details. The trend in automatic and semi-automatic systems is toward multi-row lines in fairways, requiring many more sprinkler heads as each covers a pattern of smaller diameter.

Kinds of Systems

Irrigation is as old as history but

probably more progress has been made in the last 15 to 20 years than in all the years before. The development of new materials and automated methods have gone far toward eliminating guesswork and reducing labor costs.

1. **Hoses and sprinklers** are still in use on some golf courses although they are becoming extinct. The fact that some are still in use attests to the permanency of a system—though outmoded it is sometimes difficult to sell the members an up-to-date system. This type system consists of a small, inadequate underground layout that is supplemented with hoses and revolving sprinklers set at various intervals. It has many disadvantages—it requires close watching and frequent movement of hose and sprinklers; it can be moved by golfers or caddies when the sprinkler interferes with play and often it is not returned to the original spot so control is lost; and it is a system that requires much labor since it is tedious to move sprinklers and hose filled with water. This is the least desirable of systems.

2. **Travellers** are used when water supply and pressure are limited. It is a system that has to be moved from fairway to fairway. It also needs supervision, adding to labor costs. While the initial cost is less, the subsequent cost of labor for operation is more than for quick coupling or automatic systems. The travelling sprinkler moves along a guide-wire over a fairway until it reaches the end of the wire, then when manually reversed it moves back under its own power. It is slow moving. During periods of stress, grasses could weaken before the water reaches the area.

3. **Quick coupling** systems have underground pipe throughout the course with quick coupling valves so that all the worker need do is snap on the sprinkler head and the water flows freely. When each sprinkler has been on long enough, it is moved to another area until the round of irrigation is completed. This system requires labor and supervision, usually a night man.

4. **Semi-automatic** systems are somewhat like the quick coupling except that the irrigation pattern is regulated by a time clock. The sprinkler heads are placed on fairways to be irrigated and at a set time they irrigate, then shut off automatically.

5. **Fully automatic** systems operate from control clocks spaced at vantage points throughout the course. The clocks are set and the system operates by itself—the heads lift and shut off automatically. The only additional labor needed is for supervision to see that the system is working properly.

Many factors may still influence the decision as to the type of sprinkler system to choose for a particular course, including geographic location, climate, rainfall distribution, drainage conditions, soil characteristics, topography and elevations, type of grasses used, degree of maintenance, perfection desired and economics.

Choice of Heads

Any firm dealing in the manufacture or sale of sprinkler heads can provide details of irrigation patterns with the various heads. In the main the solution lies in the nozzle size-pressure relationship. If a quick coupling system is installed and heads are spaced approximately 90 feet apart down the center of the fairway, one head must be able to cover approximately 25,000 square feet in its irrigation pattern. In the automatic system, two and sometimes three parallel lines are installed. Here the number of heads required increases from 150 or less in the case of a quick coupling

system to between 650 and 900 for a completely automatic system. In the automatic installation less pressure and smaller nozzle size is required as each nozzle covers a much smaller area than needed for the down-the-center quick coupling system.

The heads for all but the completely automatic systems are placed in position manually. The automatic heads raise hydraulically or electrically on gear or cam driven shafts.

Pumps

Expert advice is essential in the installation of the pump house setup. This is no job for an amateur. There are several kinds of pumps to choose from—centrifugal, turbine, piston, rotary, or engine. The centrifugal pump is the most widely used. Most installations include one or two 25 horsepower motors. Some require a booster pump to increase pressure at remote and/or especially hilly sections of the course.

Specifications and Bids

When a new course is being planned or when improvements to an existing course irrigation system are contemplated, club officials are inevitably confronted with the problem of who to turn to for the best advice. If the club subscribes to the USGA Green Section Service, a natural source of good advice would be the USGA Regional Agronomist. He can recommend the necessary steps and procedures and can point out the advantages and disadvantages of the various types of systems.

The first step should be the securing of a good overall plan and adequate specifications to suit the requirements of the particular club and course, prepared by a recognized and experienced expert in the field of golf course irrigation. It is no longer possible for a local plumber or someone without wide previous experience to design a modern system.

The names of capable experienced designers as well as contractors in the same category can usually be obtained from golf course architects or by contacting clubs with successful systems. Valuable information may also be obtained from various manufacturers' representatives and from reliable dealers.

Wherever possible the next step should be to invite competitive bids from reliable experienced contractors. Where automatic and semi-automatic systems are involved . . . only contractors experienced in this type of installation should be considered.

The contractor must have some idea of the requirements of the golf course grasses, and the routine of water management. This he must get from the superintendent so that the system can be geared to these needs.

An adequate plan should include the locations and sizes and specifications for all pipe, valves, sprinklers, pumps, hydraulic tubing or electrical activating systems, controllers, switches and electrical hookups. Detailed specifications for installation procedures should also be included encompassing such things as pipe and tubing-laying procedures, depth of pipe, replacement of sod, valve and sprinkler installation and finally recommended operational procedures. Plans should also include schedules of all pipe, valves, fittings, sprinklers and other equipment necessary to accomplish the work as detailed in the plans and specifications.

Besides these items there are such important details to consider as the use and storage of explosives for blasting rock, removal and replacement of fences, rerouting if obstacles

arise, provision for workmen's compensation, and property and liability insurance.

Having the golf course crew install the system under the superintendent's supervision may reduce initial costs; however, course maintenance usually suffers, sometimes beyond simple renovation repair. Many superintendents prefer to have outside contractors do the work, meanwhile keeping close watch as the project progresses.

It is good business to require a performance bond equal to the full cost of installation and it should remain in full force until the job is completed. The system should be guaranteed for a specific period and those installing it should fill the superintendent in on all details of operation.

If an experienced designer and contractor have been employed in the installation of the system, they can offer much good advice for use of the system. A capable superintendent will quickly learn how to use it efficiently.

The types of grasses to be encouraged or discouraged will be a big factor.

The tendency is usually to water too much initially in particular areas with a new system and only experience can be the teacher in this respect. General advice normally given to start off the use of an overall automatic system under average conditions is to set the controller and clock for the first month or so to a maximum of 1/4 inch of water per hour. If a fairway sprinkler delivers 60 gallons of water per minute to an area 180 ft. in diameter at about 70 lbs. pressure at the sprinkler head, approximately 1/4 inch of water per hour will be applied. After some experience and observation at about this rate of watering the experienced superintendent can soon learn to adjust his system up and down for the various areas and needs of his course. Rainfall, topography, soil and drainage conditions, type of grasses and other factors will of course enter into the daily decisions in regard to water use.

BLUEGRASSES AND FESCUES

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Editor's Note—This is a condensation of an article appearing in the November, 1964 issue of the USGA Green Section Record.

Bluegrass and fescue turf is deep rooted and relatively drought resistant. It requires thorough, infrequent irrigations. Because it is composed of "high-stooling" plants, bluegrass and fescue turf cannot survive extremely close mowing.

The prevalence of automatic watering systems and a general trend toward light frequent irrigations coupled with growing demands for close-cut turf has mitigated against bluegrass and fescue as fairway grasses. The close mowing weakens and thins out these grasses and the frequent irrigations provide an advantage to invading species such as *Poa annua* and bent.

Bluegrass-fescue turf is more cheaply maintained than the species which will tolerate close mowing and frequent watering and such turf will withstand more adversity. However, when the golfers at a club want close-cut, heavily watered turf, they have little choice except to support the cost of a bentgrass-*Poa annua* fairway.