

over 60 pounds pressure on our sprinkler system, but the higher pressure is immediately available for use in case of fire, and for which fire plugs are properly located. The club has its own fire hose equipment, which is contained in a small building and is readily accessible.

The clubhouse supply pump is a vertical triplex power pump, with a capacity of 100 gallons a minute at 100 pounds pressure, directly connected to a $7\frac{1}{2}$ -horsepower electric motor with automatic regulator and starter. This controlling apparatus works in connection with the pressure of the storage tanks and starts and stops the pump automatically, thereby maintaining abundance of water at all times for clubhouse purpose. A 4-inch galvanized wrought iron main carries the water from the storage tanks to the clubhouse.

Another important feature of the whole layout is the fact that the piping connections between the pumps, tanks, fire hydrants, clubhouse, and sprinkling piping are so arranged that they are all interconnected, which permits great flexibility of operation.

Our distribution plan on the course is based upon a 4-inch line which makes a convenient loop to cover the entire 27 holes. From this main loop, pipes are run to take care of greens, tees, and fairways. These lead lines vary in size from $2\frac{1}{2}$ inches to $1\frac{1}{2}$ inches. We have no lines anywhere under $1\frac{1}{2}$ inches. All pipe is galvanized wrought iron, which is considered practically everlasting. While this pipe is more expensive than steel, we believe it is cheaper in the end because of its greater durability. The labor cost of an installation of this kind is such an important item that it pays to use the best materials available.

I have said nothing about our sprinkler system, for the reason that I am not entirely satisfied with it. We expect to do some experimental work along this line during the present season, and I hope that some worthwhile experience may be built up which we can give to BULLETIN readers in a subsequent article.

A Water System in California

By E. W. Van Gorder

The water system of the Castlewood Country Club, at Pleasanton, Calif., is typical of the systems that have been recently installed on California golf courses. Hoseless fairway systems are becoming more popular as constant improvement in sprinklers and valves gives them additional flexibility. While the cost of installation is considerably more expensive, the great saving in labor and in hose replacement makes them more economical over a period of years. Two men can cover our fairways in 16 hours, giving them a watering of from 45 to 60 minutes. Southern California courses whose water requirements are somewhat higher than ours may require additional men.

In this state, where fairways must be watered from 8 to 10 months of the year, water costs form an expensive item in the budget. We are fortunate in having a perpetual right to 90,000,000 gallons of water a year. This is delivered free of charge to a reservoir on the lower end of our property. Any water used in excess of this amount costs the exorbitant price of 21.6 cents per 100 cubic feet. Needless to say, we try to keep within the 90,000,000 gallons, which is about enough for the course and clubhouse. Owing to the increas-

ing private consumption by members for their villa sites, we may find it profitable to sink wells and pump the balance needed. It is estimated that the clubhouse, grounds and villa sites use about 3,000,000 gallons a month during the summer. Last year during July and August the course used over 18,000,000 gallons a month. Our system was able to supply these 21,000,000 gallons, although the pump capacity is less than was originally estimated, due to faulty intake lines of the old estate which are still being used.

Ours is a gravity system and most of the water used on the course has to be lifted to a height of 640 feet, which entails quite a power bill. Last summer the power charges allocated to the course approximated \$700 per month.

The lower pumps consist of two 2-stage 4-inch centrifugal pumps each driven directly by 100-horsepower motors and each having a capacity of 500 gallons a minute. These pumps lift the water to the first set of tanks 360 feet above. The water is carried over a half mile from the reservoir to these pumps through a 10-inch riveted casing. This was used for many years as a gravity line on an old system but could not deliver fast enough for the new pumps and, owing to air leaks, could not be used as a suction line. We were bothered by the pumps going static until it was decided to use but one pump at a time which cut our capacity to 500 gallons a minute.

The second level is equipped with a 6-inch 2-stage pump with a 100-horsepower motor having a capacity of 750 gallons a minute. This lifts the water 280 feet higher, to the upper tanks. The pumps are automatically controlled by float switches in the tanks.

There are six redwood tanks with a total capacity of 42,000 gallons on the first level. These supply the clubhouse and grounds, two-thirds of the villa sites, and two of the fairways. The two upper tanks are also of redwood and hold 100,000 gallons each. These supply the remainder of the course.

The main line from pumps to tanks is 10-inch cast iron with leadite joints. The mains on the course are welded black pipe. They are 4 and 5-inch, depending on the number of fairways they feed. They are looped back to the 10-inch main which, with the exception of three spurs, gives a complete circulatory system, thereby helping to equalize operating pressure. Static pressure varies at different locations, the minimum being 90 pounds and the maximum 175 pounds. These mains run along the sides of the fairways, one line serving two fairways where possible. Every 105 feet 2-inch laterals lead into the fairway and serve from three to six sprinklers. These are operated by a control valve. From these laterals there extend 1¼-inch cross-arms. Each lateral is also reduced to 1¼ inches for the last sprinkler; that is, a single sprinkler is fed from a 1¼-inch pipe, but more than one is handled by the 2-inch. In places where the pressure is greatest, 1-inch is substituted for the 1¼-inch. All the pipe and fittings with the exception of the welded mains are galvanized. As there is no danger of freezing, they are laid just deep enough to be out of the way. The mains are down about 20 inches so that the control valves will be below the ground.

The sprinklers will cover a 40-foot radius, and the risers, which consist of 1-inch pipe, are spaced 70 feet apart, making a sufficient allowance for coverage in windy weather. These risers are cut off just below the turf and fitted with threads, the sprinklers being screwed on. There are quick-coupling valves, but these have been

developed since the course was put in and we are not equipped with them.

The greens and tees are served with 1-inch garden valves set in covered concrete boxes so spaced that a 75-foot hose is sufficient.

We are using a gearless sprinkler with shimmy vibrators on the fairways. These are very satisfactory but not quite as convenient for the operator as the latest type, in which this vibrator is eliminated. They are light and easily moved about in a wheelbarrow.

The greens are equipped with roller-mounted geared sprinklers. There are two for each green and adjacent tee. A good grade of 1-inch hose is used with these. It has been my experience that the cheapest hose is by no means the most economical.

Last summer the greens were watered every night, since they were new, but this year they are doing nicely with water every other night and some day watering of dry spots. The most satisfactory method has been to have each man come back at 6 o'clock in the evening and water the three greens and tees under his care. This takes about three hours. In this way there is no interference with the players, and probably, what is more important, there is a considerable saving of water which would be lost through evaporation if it were done in the hot sun. By morning the greens are firm for cutting and for play.

The sprinklers are moved at 30 to 45-minute intervals, depending on the condition of the green. A rough estimate would place the amount needed for one watering of the greens and tees at about 162,000 gallons. In order to equalize the demand on the pumps, nine greens are watered each night.

Fairway sprinkling is so arranged that each fairway is watered every other night. The two men doing this work start at 10 o'clock in the evening and finish at 6 in the morning. The average length of watering is 45 minutes. Each man has 45 sprinklers, and by running 20 at a time is able to set one group while the other is running. To help in finding the sprinkler connections, 2-inch disks painted with luminous paint have been nailed beside them. While it would have been better if they had been larger, they are of considerable help.

In laying out systems which are to include villa sites, care should be taken to make proper provision for these from the start. If it is at all feasible, it is best to have them on a separate system. Tanks will run dry occasionally, which is annoying to the resident. We are also obliged to shut off some of the consumers to make any minor repairs on certain parts of the course. This could have been easily eliminated if plans for these had been made when the system was first laid out.

A grassy hollow is a trouble forever unless it is drained. Ordinarily surface drainage is all that is needed.

Good bunkers not only indicate clearly the line of play, but serve as landmarks by which the distance can be more closely estimated. It is rare that a course is found on which more bunkers could not be placed to great advantage, provided they were made attractive and fair, and above all things visible. Much of the protest by players against more bunkers is because they are too often unfair. Good bunkers, more than all else, tend to make good players.