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Contents

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Water Systems and Watering

This issue of THE BULLETIN is devoted chiefly to a consideration of the ever-present problem of watering. Any discussion of water systems for golf courses will naturally be of greater interest to clubs contemplating the construction of new courses or to those remodelling the old; nevertheless, even on the oldest courses green committees are constantly faced with the question of watering and problems relating to the water system. It is obvious that no individual or group can lay down a general rule defining exactly the best way to supply water to all greens and fairways in the country. The source of supply, the demand, and the many other local conditions that must be considered make it impossible to recommend any system of watering even in a general way. The purpose of this discussion is to present different viewpoints which may be helpful to those who must decide on some system for a course.

When one visits numerous golf courses and discusses with greenkeepers and green committees the many problems of course maintenance he can not fail to be impressed with the frequency of poorly planned and wholly inadequate water systems. The false economy practiced in the installation of this indispensable feature of a course is perhaps one of the most serious evils of the construction period. In order to save enough money to build a few worthless mounds and bunkers, building committees with limited resources are frequently tempted into the mistake of reducing the allotment for the installation of the water system. Of what value are a few extra mounds and bunkers if, due to inadequate watering, players are deprived of good turf on the parts of a course where good turf is essential? A saving in the installation cost due to the use of smaller mains, for instance, is always insignificant when compared with the added expense of maintenance and the possible added cost of replacement and the interruption of play when ultimately larger mains are substituted. When visiting courses we never hear the complaint "our mains are too large"; on the other hand, the complaint "our mains are much too small" is so frequent that it becomes almost monotonous. In addition to the complaint that mains are too small, one hears a constant repetition of the complaints that pumps are inadequate, supplies are limited, laterals or outlets are too small, pressure is too low, and the like. A few of these common mistakes are briefly referred to by writers in this issue of THE BULLETIN. The mistakes of others are valuable if one has sufficient breadth of vision to utilize them.

The question as to what is the best amount of water to apply to a given area of putting green or fairway is one which is frequently asked but one which can probably never be answered definitely. The amount required on each course will depend entirely on the local conditions. This point is well brought out by the different writers; but

it is a phase of the watering problem which can not be over-emphasized. It seems self-evident that different soils, climates, weather conditions, and other varying factors will influence the water requirements of different courses. Nevertheless it is quite apparent that on many courses this variation is little understood. Many of the difficulties in maintaining good turf are due to insufficient watering. It might readily be shown that as many, or perhaps more, difficulties can be traced to over-watering or poor judgment in the application of water as can be attributed to drought. Sandy or well drained soil seldom receives too much water, but some of the courses where clay soil is general may easily be ruined by careless watering. The daily water requirement must frequently vary decidedly on the different greens about the course. It may seem unnecessary to warn that a green located in a low pocket where there is little air circulation and correspondingly less evaporation will require much less artificial watering than one located on a hill where it is exposed to constant air currents and excessive evaporation. The frequency of a standard daily watering for all greens even on courses where such extremes exist shows clearly that such warnings are not uncalled for. A green located in an air pocket, with perhaps a stream beside it maintaining a water table not far below the surface, dries relatively slowly even though it may be underlaid with adequate tile drainage. Yet how often one sees such a green being mercilessly watered simply because it was "its turn for watering." Such a green is usually referred to as "the worst green on the course to keep in condition." After hearing a recitation of the frequent attacks of brown-patch, the baked surface, green scum, and other evils that haunt that particular green, one questions how much of this difficulty may be due chiefly to an over-zealous adherence to a uniform schedule of sprinkling. When such a system of uniform watering is criticised, one is often reminded that nature waters all alike and we should make our artificial watering comply as nearly as possible with that provided in the natural rainfall. The reply to such a reminder is simple indeed. Nature does water all alike; but nature produces one group of plants on the slowly drying, air-pocketed lowlands, and quite another on the hilltops. Golf clubs choose to grow the same grass on all greens, regardless of location. Those who choose to "beat nature" on that score need feel no hesitancy in tampering with some of the other wise provisions of the natural order.

In recent years there has been a tendency to rate sprinkling systems primarily on considerations of speed of delivery. There can be no question as to the savings in labor costs, as well as the reduction in play interference, attendant on the use of sprinklers with extremely rapid delivery. On the other hand there is a very serious question as to whether this seeking after speed has been altogether in the direction of progress. Many soils will absorb water as rapidly as it can be applied with any of the modern sprinklers. Other soils, however, can absorb water but slowly. Rapid application on these latter types of soil results in much waste of water, for most of it will invariably run into low pockets or off the green entirely, leaving little on the higher areas, which are most in need of moisture. No rule can be laid down as to the most efficient rate for applying water, since each course will vary, and individual greens may vary on the same course. There is, however, a simple way to determine the proper rate for watering. After watching a sprinkler operate for an average period

on a green, it can readily be observed whether water is collecting in pockets, and a few cuts into the turf in the high and low areas will soon indicate whether the water is penetrating properly. If water collects in pockets and there is little penetration into the soil on the higher parts of the green, it is evident that the particular sprinkler in use is delivering water too rapidly. Simple as this test may be, it is surprising how seldom it is fully utilized. Sprinklers are too frequently bought, and perhaps operated for years, merely because "Mr. Smith uses them on his course, and Smith's greens are always in good condition." The sprinkler in question may be best for Smith's conditions, with his more porous soil; but after all, an old-fashioned jackknife, properly used, can furnish information on watering that is of far greater value than the opinion of all the neighbors no matter how well kept those neighbors' greens may be. There is available on the market a great variety of good sprinkling devices, which makes it possible for a club to select something which will deliver the water at the most efficient rate for its local needs—provided, of course, it is equipped with a water system which will deliver water properly at the sprinkler. As has been pointed out elsewhere in this issue, even with the best mechanical devices for sprinkling it is usually found that some hand watering is necessary to keep turf in good condition on the higher areas from which water runs easily.

When soil is thoroughly dried out it requires heavy watering gradually applied to bring it back to the proper moisture content. The behavior of droplets of water on a dry, dusty surface is well known to everyone. It is often difficult to moisten a dry powder to form a thick paste, but when the powder is once thoroughly moistened and worked into a paste there is little difficulty in making it absorb more water. The same principle applies in a general way to soil thoroughly dried out as compared with soil even slightly moist. At times soil may become excessively dry, due to some disturbance below ground. Grubs working just below the surface, a layer of sand, a large stone, copper poisoning, and other similar conditions may cause large patches to dry out very rapidly, and these areas may become so dry and powdery that the soil is seemingly impervious to water and requires ususual care to wet it and to keep it properly moistened.

We are frequently asked, "When is the best time to water turf?" Grass apparently is like humans in at least this one respect; it can be safely fed and watered at any time that is most convenient, provided the frequency and the quantity are wisely proportioned. In the different discussions here given it is apparent that the writers have no fear of injuring turf by watering when the sun is shining. Some time ago there seemed to be a rather general belief that watering foliage during sunny periods would result in any number of evils, such as brown-patch, sun-scald, and yellowing. It was pointed out that when nature watered plants the direct sunlight was cut off, and in order to imitate this provision all watering should be done in the absence of direct sunlight. This theory now apparently has little influence on golf course watering programs. There are, however, certain considerations, such as interference with play, periods of difference in water pressure, disease, or other factors, which may have important bearings on the most suitable time for watering on many courses. Such questions must be determined by those in charge of the individual clubs, and, as indicated in the accompanying articles, there may be several "best times for watering."

Golf Course Water Supply

By Kenneth Welton

As a rule golf course water systems have proved inadequate. Experienced water supply and hydraulic engineers generally seem to consider such systems too simple a matter to be given much concern. Part blame for failures sometimes attaches to golf course construction committees, who do not always appreciate the demands put upon a water system during hot, dry weather, and as a consequence cut to the utmost the allotment for installation. No greenkeeper, however competent, can keep a course in the excellent condition now required, without adequate water facilities. A system of small pipes with low pressure and perhaps other deficiencies increases the cost of watering by a sum of money that could be used advantageously in other maintenance work.

The water requirements of a golf course may be estimated approximately from a study of the rainfall. The average monthly rainfall for 12 eastern and middle-western states for June, July, and August is roughly 3½ inches. For September and October the average is about 3 inches. In the West and South these figures do not apply. The above average rainfall is sufficient to keep pasture vegetation alive even though the rain may be very heavy and followed by long droughts. It does not, however, suffice to keep the turf in the continuous vigorously growing condition such as is demanded on golf courses, especially on greens. Close cropped grass does not have the deep root system found among the cultivated crops and therefore is more subject to water shortage since the surface layer of soil dries first. If nature does not provide 3½ inches of well-distributed rain per month during hot, dry weather, artificial irrigation is necessary. If 4 inches is taken as equivalent to the rainfall for a month somewhat above the average, we find that the average daily rainfall should amount to about ⅛ inch, or ¼ inch every two days. An average putting green of 6,000 square feet would therefore require approximately 500 gallons every day, or 1,000 gallons every two days. An acre (43,560 square feet) of fairway would require approximately 3,500 gallons every day, or 7,000 gallons every two days.

There are a number of nozzles and sprinklers on the market which, under 40 pounds pressure, discharge 15 to 20 gallons of water a minute. One-inch hose is usually regarded as the most satisfactory size for golf course sprinkling. Allowing 10 pounds loss of head for the friction in 100 feet of 1-inch hose, water delivered to the hose connections at a pressure of 50 pounds should therefore water an area of 6,000 square feet sufficiently in about one hour every other day. It is ordinarily not good practice to apply 1,000 gallons of water to a green of that size in less time. If more water is necessary, it is more desirable to increase the time for watering rather than the volume of water. To apply water too rapidly to some greens will expose the root crowns of the grass and also leach away fertilizers previously applied. All putting greens can not be treated alike. Sandy greens may absorb water very quickly if there is no interruption in their naturally good soil drainage; whereas greens that are built of heavier soil, or greens having poor soil structure, will not absorb water as fast. Of course, nature can not be controlled; but we can control artificial watering. A long, gentle rain always helps vegetation more than a short, hard rain. Frequently courses are

found that are over-irrigated, it being thought that the off color of the grass is due to lack of sufficient water, when often the real cause is lack of fertilizer.

Skilled engineers who specialize in golf course irrigation are few and often the expense of retaining such men is considered to be unjustified. In many cases an understanding of the principles of hydraulics, together with practical working information, will be sufficient for a construction committee, construction superintendent, or greenkeeper in the installation of a new water system or the improvement of an old one. In laying pipe it is sometimes possible to get men who have had some steam fitting or plumbing experience; and as the fitting of pipe on golf courses is comparatively simple, it will only be necessary to have a plan to work from and intelligent supervision. The use of a large number of fittings should be avoided where the correct connection can be made with a few. With threaded pipe all male ends should be painted with graphite or red lead before the connection is screwed up. Joints should not be made so tight as to split the fitting or strip the threads. No trenches should be refilled until the system is tested at the maximum pressure and all leaks are repaired.

Since 1-inch hose is desirable for use on putting greens of present-day size, it is good practice, even for a single hose connection, to use no pipe smaller than 1¼ inches. If the pipe is long, or used to supply two nozzles at one time, it should be larger than 1¼ inches. The waterway or area of the bore of pipe is proportional to the square of its diameter. The pipe sizes of a distribution system are usually proportioned approximately on that basis, although such procedure results in increased loss of pressure and flow in the laterals. On that basis a 2-inch main would feed two 1¼-inch laterals or a 1½-inch lateral and a 1¼-inch lateral. A 2½-inch main would feed a 2-inch lateral and a 1½-inch lateral. A 4-inch main would feed a 3-inch lateral, a 2-inch lateral, and a 1½-inch lateral. Too much emphasis can not be given to the importance of large pipes, because increased frictional resistance and diminished pressure and discharge always follow from increasing the length of a pipe line or reducing its size. Farmers' Bulletins 1426-F, "Farm Plumbing," and 1448-F, "Farmstead Water Supply," give further information on friction losses and pipe discharges, and will on request be mailed free by the United States Department of Agriculture.

Pipe that will not be used during the winter need not be laid below frost depth. Outlets must come to the surface, and in cold climates pipe lines must be drained. It is a simple matter to place blow-offs at low points on the system so that the greenkeeper can drain the whole water system before the severe frost sets in. In case of a leak the location usually shows quickly on the surface of the soil, and with a shallow laid pipe line repairs are easy to make as compared with similar work in a line four or more feet deep. Most of the lines of the smaller sized pipe can be laid at the bottom of a trench or furrow made by a plow. Since breaks may occur in pipes, it is advisable to lay most of the pipe line in the rough, and for the same reason it is not wise to lay pipe lines under greens, tees, or approaches.

Clubs lacking the services of a competent engineer should lay out the proposed pipe system on paper and plan how the lines should run in order to cover the course most effectively and at the least expense. By working back from the outlets, through the various lines, one should be able to determine the approximate size of the main, which

should never be smaller than the discharge outlet of the pump, and to the first lateral branch or branches is usually one or two sizes larger than such outlet. Differences in pressure due to elevation should also be taken into consideration. Pressure is usually stated in pounds per square inch. A head, or difference in level of 1 foot, equals .43 pounds pressure; a head of 10 feet equals 4.3 pounds pressure; a head of 100 feet equals 43 pounds pressure. If, for example, the highest green is about 100 feet above the pump, the pump must be capable of delivering the maximum quantity of water required at one time and maintain a pressure of at least 43 pounds, plus 50 pounds at the highest connection, plus the pipe friction loss in the main and laterals through which the flow occurs. If the pipe sizes and lengths are such as to give a friction loss of 10 pounds, the required pressure at the pump as indicated by a gage on the pump discharge would therefore be about 103 pounds. The suction lift, including friction loss in the suction pipe, should be included to make up the total head against which the pump must operate. This is usually less than 10 pounds. The supply of water to any green is readily regulated by throttling the gate or nozzle openings.

Clubs usually require also a certain quantity of water under pressure for the clubhouse and fire protection. A common practice is to install one or more hydropneumatic tanks into which water and air are forced by an electrically driven pump arranged to start when the pressure in the tank falls to about 30 pounds and to stop when the pressure reaches 50 or 60 pounds. For watering the course some clubs find it advisable to pump into an elevated tank or reservoir from which the delivery is by gravity flow. In other cases a centrifugal pump forces water directly into the distribution lines. Sometimes the source of supply is an artificial reservoir or a natural lake, pond, or stream. Sometimes one or more wells are necessary. In all cases the pumping equipment should be such as is adapted to the conditions and the requirements.

Provided little or no fairway watering will be done, a maximum demand in most instances of 15,000 gallons per hour, or 250 gallons per minute, suffices. If fairway watering is anticipated, larger pumping and storage capacity will probably be required to meet the demands. Assuming the supply is available or has been developed, a club may proceed to the purchase of pumping equipment guaranteed by the manufacturer as being capable of delivering a specified quantity of water against a given head.

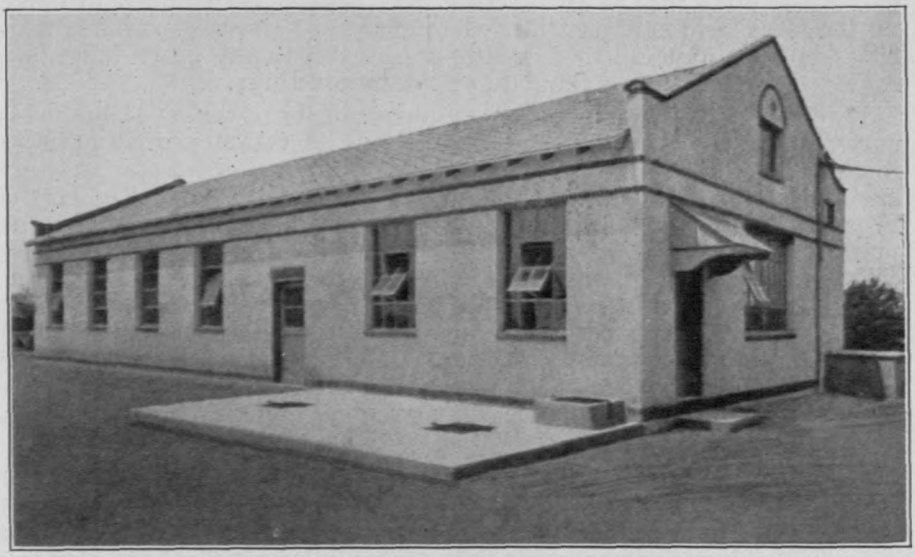
Keep a plan of your water system.—Remember that the best water system devised is likely to require some additions or modifications in future years. If an accurate plan of the mains and laterals is preserved it may avoid much added expense and inconvenience in later years. Frequently it is decided to connect a new lateral, and unless plans are available much digging may be necessary before the nearest main is discovered. All this is expensive and disturbs play. The personnel of a golf club often changes, and if the water system plans are trusted to memory they may soon be lost. Be sure to have a carefully prepared diagram; then file it where it will be preserved and available at any time.

Water System of the Country Club of Atlantic City

By H. Kendall Read

The Country Club of Atlantic City is located on the mainland about five miles from the coast. There are 27 holes, and the soil is of a very light sandy texture. The course is in play 12 months of the year and receives unusually hard wear. While the sandy soil provides ideal drainage, at the same time it requires a large amount of water particularly in periods of drought.

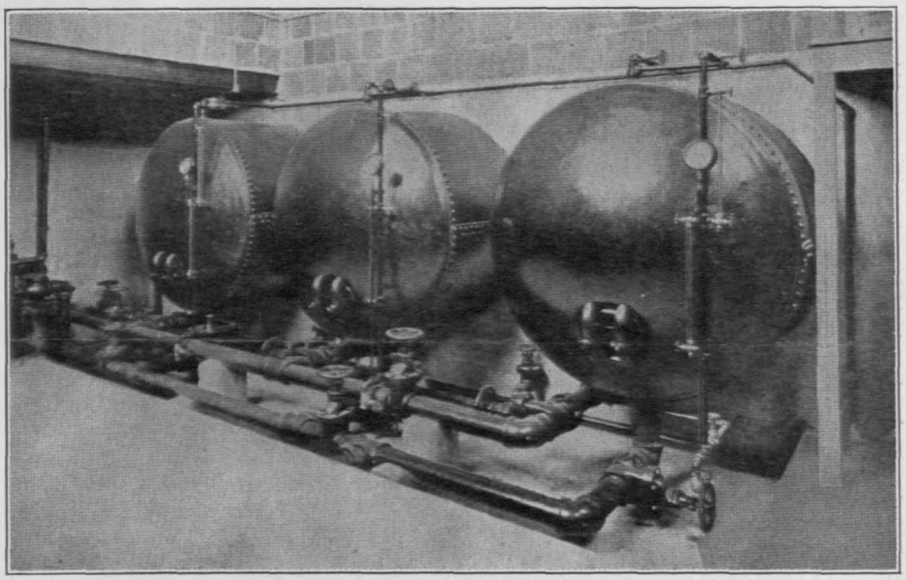
Before we created the present water system we depended upon a local water company, and neither our supply nor pressure was sufficient for our needs. As we had no stream on our property and the spring supply was insufficient we had to make recourse to a well. A 10-inch pipe-casing well was drilled to a depth of 180 feet, and we



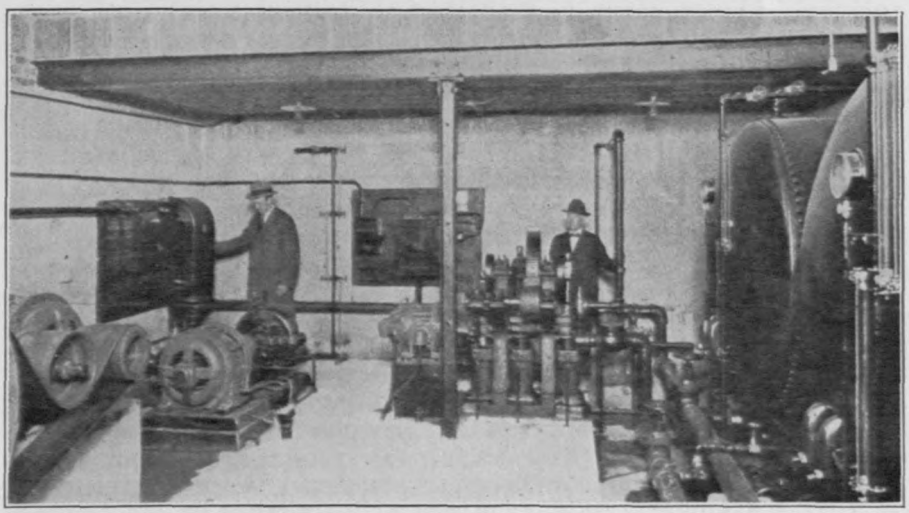
General utility building at the Country Club of Atlantic City, used for storage of golf course equipment, workshop, and housing the water-supply pumping plant.

struck an excellent water-bearing stratum at 134 feet. As this water stratum continued to a depth of 174 feet we were permitted the use of 40 feet of 8-inch screen. After this well was finished it was found that the natural water level was 25 feet from the surface but its pumping level was 40 feet from the surface. This compelled the use of an air compressor instead of a suction pump. After completion the well was given a 30-hour pumping test, which not only cleaned out all the fine sand but showed us that the well had a capacity of 500 gallons per minute. It was necessary to erect a building to house the pumping equipment, which was made large enough at the same time to provide a first-class workshop and storage room. This building is 70 feet long by 30 feet wide and is absolutely fireproof. All the pumping machinery is in one end in a space the width of the building, 30 feet by 20 feet, which space was excavated to a depth of 10 feet.

The system includes three large storage pressure tanks, two 36 feet long and 6 feet in diameter, and one 24 feet long and 6 feet in



Storage tanks for clubhouse water supply at the Country Club of Atlantic City.



Interior of the pump room, Country Club of Atlantic City, showing electric-driven centrifugal pump (left) and vertical triplex clubhouse water-supply pump (right). On the extreme right are the storage tanks.

diameter. These tanks extend back under the building with their ends protruding into the pump room for necessary connections. To obtain the water from the well an air compressor with a capacity of 500 gallons a minute is used. The water runs from the well top by gravity to a reservoir 20 feet long, 10 feet wide, and 10 feet deep, constructed adjacent to the pump house but absolutely separate. Of course all of this construction work is of reinforced concrete.

For watering the golf course we use a horizontal centrifugal pump directly connected to a 50-horsepower electric motor with a capacity of 450 gallons a minute against 125 pounds pressure. We do not use

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 7½-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 2½ inches to 1½ inches. We have no lines anywhere under 1½ 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.

Water Systems of the Philadelphia Country Club

By M. E. Farnham

The two courses of the Philadelphia Country Club are about eight miles apart and the water system of each is a distinct unit.

At our Bala course, one of the oldest courses in the district, the water is obtained from a stream which crosses the property. The flow of water is about 200 gallons a minute. A small pond supplies the intake to the system. The water is hard and also is likely to carry considerable sediment into the system. The pump house is located about 50 feet from the pond, the pump itself being only 4 feet above water level. The pump is a triplex displacement pump rated at 135 gallons a minute at 100 pounds pressure. It is driven by a 10-horsepower electric motor automatically controlled. The pump starts when the pressure drops to 70 pounds and stops at 90 pounds. The water is delivered direct to a pressure tank located on the slope at the rear of the pump house. The size of this tank is 6 by 36 feet.

The course is piped with mains to its various parts. The pipe and fittings are galvanized iron, reducing from 5-inch at the tank to 1½-inch outlets along the fairways and 1-inch outlets at the greens and tees. All valves are brass gate valves and are set in boxes below the surface. The pipes are laid about one foot deep. Each green has two outlets, placed at opposite corners. There is an outlet at each tee, and from one to three outlets for each fairway. Control valves at various places on the course permit cutting off part of the system if necessary.

There are three weak points warranting emphasis in connection with this system. The automatic control has at times failed to function properly, resulting in damage to the motor. There are not enough outlets along the fairways. The capacity of the pump is not sufficient during dry spells.

At our Spring Mill course, which was built in 1925, the source of water supply is a stream largely fed by springs on our property. The flow is only about 100 gallons a minute, but a pond furnishes a reservoir of 1,000,000 gallons. Here also we have a hard water carrying considerable sediment, especially after rains. The pump house is located at the dam and the pump is 6 feet above water level. In this case we have a centrifugal pump, rated at 300 gallons a minute at 120 pounds pressure, driven by a 30-horsepower electric motor. The control is manual. The water is delivered direct into a 6-inch main, which after leaving the pump house branches off to supply the various parts of the course. All pipes and fittings are galvanized iron, laid about a foot deep. The valves are 1-inch brass gate valves situated in underground boxes. There is an outlet at each green and tee, and along the fairways outlets are placed approximately every 80 feet.

The water system at our Spring Mill course has given perfect satisfaction at all times. The supply of water would, however, not be sufficient for constant watering of the fairways, should that be necessary, but to take care of such a contingency provisions have been made for connecting with the local water supply.

At both of our courses the water system is used only for watering the course, and our program of watering is the same for each course. In the Philadelphia district the watering of fairways is necessary only during dry spells, except on such courses in adjacent New Jersey

as are built on sandy soil. Some years the watering of fairways is not necessary, and in most seasons the turf is not killed in the absence of watering. Nevertheless watered fairways are distinctly better than fairways which are allowed to remain unwatered throughout the season. When the ground begins to get hard and dry we keep fairway sprinklers going on some part of the course 24 hours daily. We use a number of types of portable sprinklers with ¾-inch hose. We have found that a sprinkler which throws a small amount of water and can be left in one location for several hours will keep the turf at that place green for more than two weeks even in the driest season. This is on a clay soil.

We water our greens and tees in the morning. When for any reason it is desirable to be through with the watering at an early hour in the morning, we begin to water before the usual work hours. We do not approve of night watering if it can be avoided. In the first place, it is difficult to get dependable men for night work; in the second place, even a good man can not see to work to best advantage at night. We use sprinklers with ¾-inch hose for all routine watering, having found this to be the most efficient method, the ground being more thoroughly watered in this way. Hand watering is likely to be superficial.

Under our conditions the most important feature of a sprinkler is that it have no small outlet holes to become readily plugged with the dirt which is in our water. This is a feature which is likely to be of considerable importance where surface water is used. Gears or rapidly moving parts in a sprinkler are also a potential source of trouble.

We have no standard length of time during which we water, having found it impossible to work out any such standard, due to the wide variation on our courses in soil condition, areas to be covered, sprinkler volumes, and water pressure.

Golf Course Irrigation in Florida

By Joseph P. McAloon

Fortunately for golf courses on the eastern coast of Florida, irrigation does not present a problem as serious as in most other sections of the country. St. Augustine Links are operated only four months in the year, from December 15 to April 15, and during that particular time our fairways, which consist of Bermuda grass and carpet grass, seem to require little, if any, watering, since these grasses are dormant during that period. In fact, it seems that the only occasion for watering our fairways is when we are renovating them or establishing a turf. After the turf on the fairways has been established the normal rain supply during the year seems to take care of the situation nicely. During the eight months the course is closed there is very little watering done on the greens and tees, other than what is necessary whenever renovating the turf. During the playing season the greens and tees are watered practically every day with regular ¾-inch sprinklers, and for this we are using two-purpose sprinklers, which are proving satisfactory. During the operating season we use 1½-inch hose fitted with a home-made galvanized iron sprinkler for drenching the greens after they have received an application of top-dressing or commercial

fertilizer, and about a half-hour's watering with this size hose on each green seems to be sufficient. All watering during the operating season is confined to the late afternoon, in order to avoid interference with play. During the winter, however, greens and tees, and fairways if necessary, can be watered any time of the day without injury to the turf. We have no accurate data as to the quantity of water used during any given period on the fairways, greens, and tees, as the quantity of water applied and frequency of application necessarily depend on weather conditions, and consequently more watering is required some years than others. For instance, last winter was unusually long, extending well into May, and as a result we were able to maintain perfect greens with only two applications of top-dressing and about four light applications of commercial fertilizer, and very little watering was necessary outside of drenching the greens for about one-half hour after the application of the top-dressing or commercial fertilizer.

The source of our water supply is two 6-inch wells located about 1,000 feet apart and connected. These wells are driven to a depth of about 255 feet, producing a head pressure of about 14 pounds. The water from these wells is the regular hard sulphur water generally obtained and used in this vicinity.

For pumping purposes we have a 25-horsepower oil engine connected to a 3-inch split-case, centrifugal, belt-driven pump. This pump, of course, is connected to the wells with a by-pass, pumping the water direct from the wells into the entire water system throughout the golf course and giving from 65 to 70 pounds pressure. The connection is by-passed so that we can shut off the pumping unit and use the water direct from the wells whenever we have only light watering to do. Of course, when we are watering all over the links it is necessary to have the pumping unit in action.

The water is distributed through galvanized pipes, starting from the wells with 4-inch mains, with 3-inch, 2½-inch, and 2-inch branches up to the greens and tees. On the boundary lines of each fairway we have 2½-inch and 1½-inch standards with 2½-inch and 1½-inch valves located about every 100 feet, with one such size standard located conveniently for every green. In addition to this we also have from one to two ¾-inch standards for ¾-inch hose located close to each green as well as one ¾-inch standard located conveniently for each group of tees. All pipe is laid to a depth of about one foot. The clubhouse supply is obtained from a separate 2-inch well, which takes care of the clubhouse exclusively and is not connected with the ground water system.

I might add that our water system as originally installed seems to be taking care of the entire situation adequately, and no important changes in the system have been necessary.

Bare, steep banks may be made attractive with a covering of vegetation. Japanese honeysuckle is excellent for the purpose. It spreads rapidly, but is difficult to eradicate if allowed to spread into turf. It is found growing wild over much of the country. The Wichurian rose is also excellent for the purpose, and has most attractive foliage; it is easy to handle and not difficult to destroy. The common periwinkle and English ivy are most attractive plants, especially for shady places, but are rather slow in getting established.

Water Supply at Pittsburgh Field Club

By John McNamara

At the Pittsburgh Field Club, Aspinwall, Pa., we water our greens and tees from an 80,000-gallon reservoir situated near the clubhouse and utilized also as a swimming pool. Our drinking and cooking water is supplied from a 135-foot well and is pumped into a pressure tank in the cellar of the clubhouse. We also have a gravity tank of 35,000 gallon capacity for supplying the clubhouse and showers, which use from 20,000 to 25,000 gallons of water a day during the summer months. It is difficult to determine just how much water is used for irrigation purposes on the course during the dry weather, but one would be reasonably safe in estimating a daily consumption of about 40,000 gallons. We do not water our fairways. All of the greens are watered by hand the first thing in the morning, which is the most convenient time of day, since at that time there are not many players on the course. I find that watering the greens by hand distributes the water much more evenly than do sprinklers. The tees are watered any time during the day with double rotary sprinklers. The outlets at the greens are ¾-inch, and the hose is the same size. We do not use any nozzles for watering the greens.

The water for our reservoir is obtained from a deep well, and it is remarkably soft. It is pumped by a deep-well pump having a capacity of from 55 to 60 gallons a minute, driven by a 7½-horsepower motor. From the well the water is pumped into a cistern holding about 7,000 gallons. From this cistern it is then pumped by a triplex pump driven by a 10-horsepower motor, through a 4-inch line, into the reservoir, which is elevated 325 feet above the cistern. From the reservoir the water is run by gravity to the greens and tees. The main line is 3-inch, branching off to the greens with a 2-inch line and to the tees with a 1½-inch line. I might say, however, that this main line should have been at least 4-inch. The pipe is laid at a depth of 10 to 18 inches. The triplex pump is capable of pumping 90 gallons a minute, but is geared down to pump only the amount taken out of the deep well.

The mistakes that most clubs make these days when installing their water systems is that the main lines, outlets, and pumping equipment are much too small to take care of their needs. In the past, whenever replacements were necessary, I have always made the replacements much larger than they had been. For example, in replacing a 2½-inch line I would put in a 4-inch, and in replacing a 60-gallon capacity pump I would use one of 90-gallon capacity.

For each pump and motor we have in operation we have an extra pump and motor in reserve, so that if one should break down the auxiliary pump or motor could be promptly installed. We also have two extra wells which can supply us water to the same extent as the wells in operation.

The weight of a roller best suited for any particular putting greens necessarily depends on the character of the soil. On sandy soils rollers of the heaviest weight can be used. On clays or clay loams, or even on loams, a roller no heavier in weight than is sufficient to smooth the green properly should be used. The general rule is to use the lightest roller that will give the desired effect. With water-filled rollers the weight can be regulated at will.

Cheaper Nitrogenous Fertilizers Possible

"In the last few years the impending shadow of competition has forced new improvements and economies in the Chilean industry," said Dr. F. G. Cottrell, chief of the fertilizer and fixed-nitrogen investigations of the United States Department of Agriculture in a recent address before the National Fertilizer Association, as he discussed the control of nitrate prices by the Chilean producers of nitrate of soda. This control, Dr. Cottrell explained, has existed now for almost a century, since during that time the nitrate of soda fields in Chile have been the cheapest and by far the most abundant supply of the world's requirements of this fertilizer. The impending competition which promises to lower the prices of the Chilean monopoly is the steady development of the artificial fixation of atmospheric nitrogen.

"Competition from artificially fixed nitrogen," continued Dr. Cottrell, "came first from Norway, with the inauguration of the arc process about 1905. Then about 1911 the cyanamide process began appreciably to outstrip the arc process. Limitations of this process, however, militate strongly against the possibility of its ever achieving a large enough tonnage or a low enough cost to justify it in attempting to wrest price control from the Chilean producers.

"Significant developments, however, followed progress in a group of processes designated as the direct synthetic method of ammonia production. These processes consist in passing a mixture of three volumes of hydrogen and one of nitrogen over a so-called catalyst; that is, a substance remaining itself essentially unchanged but causing these two gases to react chemically so as to form ammonia.

"Although the nitrogen interests us primarily, the hydrogen is by far the more expensive constituent in the mixture. Hence the production of synthetic ammonia by plants operating commercially on hydroelectric hydrogen still encounters limitations with regard to the availability of cheap electric energy, although a number of plants enjoying favorable power conditions can operate profitably.

"Fortunately we have other methods far less sharply limited in their possibilities. New technical developments have opened practically unlimited opportunities for expansion as regards availability of energy and raw material. Most of these new methods extract hydrogen from water by combining the oxygen in the water with some other element.

"Our own war-time attempt at building a direct synthetic ammonia plant, namely plant No. 1 at Muscle Shoals, was based on this process. The synthetic ammonia plant of the Atmospheric Nitrogen Corporation, at Syracuse, N. Y., is a direct lineal descendant of Muscle Shoals plant No. 1. The Syracuse plant began after the war on the basis of experience and development furnished at Muscle Shoals with an initial rated plant capacity of about 15 tons of nitrogen a day, or about half that of nitrate plant No. 1. It has been steadily developed, and its output is now several-fold greater than it was originally.

"The nitrogen problem has come to revolve about fuel in general, and coal in particular. As this raw material is abundant and widely distributed, a broadly competitive nitrogen fixation industry will almost inevitably develop. This industry, from its scope and relative absence of limitations on its raw materials—air, water, and coal—

must of necessity supersede Chilean sources as the arbiter of price levels in the world market for nitrogen.

"This is not meant to imply that Chilean production will cease or even sink to insignificant proportions. It may, in fact, actually increase, but the significant point is that it will have to follow and adjust itself to the world price level established by the attainable costs in synthetic production, instead of being able itself to determine this level solely with respect to existing Chilean deposits, traditional methods of operation, local labor costs, and the Chilean Government's necessity for revenue."

Although from a fertilizer standpoint the interests of golf clubs are chiefly centered in sulphate of ammonia, which is a byproduct of the coal gas and coke industries, the price of sulphate of ammonia was "always indirectly fixed by that of sodium nitrate," explained Dr. Cottrell. The anticipated decreasing costs in the artificial fixation of atmospheric nitrogen will therefore indirectly tend to lower the price of sulphate of ammonia.

Shade grasses.—In the north the best shade grasses for turf are red fescue, fine-leafed fescue, and rough-stalked bluegrass (*Poa trivialis*). The first two are especially desirable for sandy or gravelly soil, but if sown alone they succeed even in clay. The last is generally the best in clays or loams. In the south the best shade turf is made by St. Augustine grass; this grass is started from stolons, as seed is not on the market.

A Golf Course Without a Water System

By W. C. Capron

The problem which we have been obliged to face at the Anaconda Country Club is not an ordinary one. To understand the conditions here it will be necessary somewhat to describe our community. Anaconda, Mont., is a town of 10,000 to 11,000 inhabitants. The only industry is a large metal reduction works employing about 3,000 men. This means that we are all working men and comparatively few receive more than modest recompense for our services; therefore the Country Club fees have had to be kept low or the membership would be extremely small. The Country Club was started 10 or 11 years ago, and the fees adopted at that time still maintain. They are: resident membership, $25 initiation, $20 per year dues; non-resident membership, $12.50 initiation, $10 per year dues; women's membership, no initiation, $10 per year dues.

It was a struggle to keep alive up to about five years ago. Since then the club has been forging ahead rapidly; the course has been changed from 9 to 18 holes and many improvements made. At the present time the total amount we are able to spend on the golf course for both upkeep and improvements is around $1,500 per year. With so small a sum, major improvements are impossible and we must use sand greens. We can not put in an irrigating system for our fairways. These considerations made it imperative that we find a grass which would grow without irrigation, other than that obtained from nature; one which would form a continuous turf, would not winterkill, would grow on bare gravelly soil, and would spread.

The two grasses most common in this region are blue joint and

redtop. Both of them grow in bunches and not continuous and are therefore totally unsuited for a golf course in this region.

After a number of years experimenting and observing we found that the long-leafed salt grass met all the conditions enumerated above. Its color is not particularly pleasing and it turns brown early in the fall, but it forms a continuous turf, spreads rapidly with constant cutting during the summer, and simply will not kill. The farmers despise it on account of the difficulty in removing it. About four years ago we began to send men out each fall to gather what they could, put it in sacks, and store it until spring. The seed is very fine and blows away with the least wind.

Early in the spring we lightly harrow the worst parts of the fairway, seed these places by rubbing the grass to separate the seed, brush, drag and roll, then trust to nature. Two years ago we raised $300 by subscription and spent it turfing the approaches to the greens. To make the money go as far as possible we placed this turf in strips —12 inches of turf, with 6-inch spaces between, 50 feet out from the green, knowing that these spaces would fill in within two or three years. This proved very successful, these approaches being nearly solid salt grass turf now. The salt grass is now very much in evidence on all our fairways, and on a few of them covers probably 25 per cent of the fairway.

In 5 or 10 years our fairways will be covered with a continuous turf of salt grass and then we will have one of the best and, because we have a clear mountain stream running through the course, one of the sportiest golf courses in this part of the country.

(In these days of elaborate golf courses with their expensive equipment it is always instructive to learn what some clubs are able to accomplish, with limited facilities, even under extremely adverse conditions. After reading the articles in this BULLETIN on watering turf one is likely to gain the impression that a prerequisite of a golf course is an abundant supply of artificial water. To disprove this we include Mr. Capron's interesting account of what has been done at the Anaconda Country Club to meet conditions which are decidedly unfavorable to ordinary turf grasses—and all without the aid of artificial watering. The game of golf, we understand, passed its somewhat obscure yet doubtless sporty infancy in cow pastures, where machinery and other expensive equipment were not dreamed of. Today some individuals think of golf only in terms of palatial clubhouses and vast expanses of perpetual green. Others apply the old adage "where there's a will there's a way" and "play the game" in more ways than one. After all, the old game is much the same. Aside from the question of turf and artificial watering, does it not raise the query, What is true sportsmanship?—EDITORS.)

The direction of a fairway is governed by a number of factors, chief of which are perhaps topography and the general layout of the course. It is generally considered, however, that fairways extending north and south are to be preferred to those extending east and west. The heaviest play on a golf course is perhaps in late afternoon, and then it is that the sun shines directly down an east and west fairway, much to the annoyance of players.

Caddies' shelters and parking spaces should be kept in the background, or screened with trees or shrubbery, as much as possible. Let emphasis be placed on the natural features of the golf course, and let the accessories be concealed.

AS WE FIND THEM

One of those helpful souls, Mr. Average Golfer, remarked, "Every time I come out here to play someone is in the way mowing, weeding, top-dressing, applying chemicals, or in some way puttering around. The grass on this course is good enough for anyone to play on. So why don't they let it alone?"

The long-suffering G. C. C. replied, "Did it ever occur to you that the reason why the grass on this course is good enough for anyone to play on might be due to the fact that someone is always puttering around on it? Every time you come out here you probably change your clothes and have a meal. You look sufficiently well groomed and nourished. Why don't you let yourself alone and quit changing clothes or eating?"

One old applicant for membership in the Hole-in-One Club was about to be elected but was blackballed by a worm-cast. Instead of going after the worm he looked up the green committee. Finally, one of the green-committee members had a chance to speak. "Aren't you one of the members of the self-appointed economy committee? Seems to me I remember hearing you on several occasions object to any additional expense for 'frills' such as worm or grub eradication. We thought you believed in keeping things as nearly as possible like nature provided them.

"You know, Dame Nature just loves to put worm-casts on the lines of long putts; and if she gets a chance to slip one in the way of a hole-in-one, so much the better. Just think how much fun Dame Nature must have watching big men chase those little pellets over green fairways and through dense thickets. Can't you hear her chuckle when one of her big 'masterpieces' explodes because her humble earthworm makes it necessary for him to take two shots to a hole—especially when that particular 'masterpiece' heretofore championed the cause of earthworms in the name of economy?"

Another locker-room reformer wanted to know, "Why do we use all those chemicals on the greens here? The fellows over at the Clover and Dandelion Country Club tell me we are getting ourselves in for a lot of trouble. They admit our greens look better than theirs, but they say we will suffer for it later."

His G. C. C. asked him if he had ever listened to a tramp discourse on the subject of frequent baths. "Baths will get you into a lot of trouble. They may make you look a little better for a time, but you will suffer later."

One well known observer of the human race concluded, "A fool is born every minute."

Had he been a G. C. C. he undoubtedly would have added, "and each seems born for the great purpose of telling the green committee how to run his golf course."