

tained in the surface soil would be buried and to a large extent lost to the grass. Such land would, of course, be benefited by applications of loam or compost; but this is usually too expensive a treatment for large areas. A cheaper method is to apply barnyard manure at the rate of from 20 to 30 tons per acre. By setting the disks in such cases at an angle the manure can be well incorporated into the soil.

BREAKING THE LAND

When the land is cleared of obstructions, whether it has been in cultivated crops, grain, pasture, or waste, it should be plowed and disked as soon as possible. Plowing should be as deep as practical, but not deep enough to bring up too much subsoil. Continuous cultivation for several weeks before planting greatly improves the physical condition of the soil, increases bacterial action and decomposition of organic material, conserves soil moisture, helps to eliminate weeds, and aids in the final leveling work. If there is sufficient time it will be well worth while to plant some green-manure crop to be turned under before planting. If there is no time for growing a green-



Digging a wide, open ditch with a wheel scraper on the side of a low fairway in Florida. The fill is being used to raise the fairway and to build the green and tee.

manure crop, and if manure is available, it is well to disk in a liberal top-dressing of manure (20 to 50 tons per acre) several weeks before seeding to allow time for decomposition and mixing with the soil.

GRADING

On land which has been cleared of timber there are bound to be holes of various sizes left where stumps have been removed. These should be filled, or otherwise they may be flooded and make further work difficult. These holes may often be used to advantage as places to bury stones.

On most courses the chief problems of grading will be around the greens, for it is there that the most extreme filling and excavating will be done. This part of the work usually raises the serious question as to where soil for the elevated portions can be obtained and where suitable topsoil may be secured. If there is likely to be any scarcity of topsoil, the best method is to stake out the full extent of all cuts and fills and then remove all topsoil from these areas. When the topsoil has been removed the cuts can be made for the traps, and

the earth from these may be used for filling. Where traps are shallow and can not provide sufficient soil for filling to bring greens up to the desired elevation, it is necessary to obtain earth from some other locality, frequently from open ditches or the so-called "borrow pits" located where they will not mar the landscape. It is well to insert a word of warning against an all-too-common habit of construction men,—that is, the removal of good topsoil from approaches or other areas of fairways which happen to be most convenient. It must be remembered that members of golf clubs demand good turf on the approaches as well as on greens, and it is not fair to rob these areas of all good topsoil. Rather than use topsoil from approaches or fairways it is better economy to go to the rough for it, even though the haul may be longer.

The same care in conserving topsoil about the greens should be used in constructing tees and bunkers or even in leveling the rougher portions of the fairway. This topsoil can be replaced when grading is finished, to provide a suitable layer for the seed bed.

DRAINAGE AND WATER SYSTEMS

Soils that contain sufficient organic material or, in some cases, sufficient sand, to be normally mellow, but which on account of insufficient elevation or an impervious subsoil are kept in a saturated condition, will be greatly improved by removal of free water. In some cases this can be accomplished by open ditches, but usually on golf courses underground tiles are necessary. Soils vary so in texture, even soils of the same type, and possess such different water-holding capacities, that it is almost impossible to indicate the proper depth and placing of tile lines for all soils. A certain amount of experimenting must be done by each golf course to determine the drainage characteristics of its soil or soils. If soils are over-drained, they will require more water; and if this water is applied as frequently and in as large quantities as needed, there will be too great a leaching away of otherwise available plant food. Ordinarily a soil should be drained no more than is necessary to dry it in the spring as soon as naturally well-drained soils in the neighborhood become dry or to keep them tillable as late in the fall as such neighboring soils are tillable. Golf course properties should be drained during construction, so that all parts of the property may be worked alike and, as stated above, as early in the spring as naturally well-drained soils may be worked. Before golf course properties are worked over, planted, rolled, and tramped upon, the drainage required for the soil may be ascertained. Once the course has been played on, provided the plowed and tilled soil has been sufficiently drained, any areas of hard or impervious soil that develop should be improved in mechanical structure by the addition of organic material or sand, and in some cases both.

Drainage work should be completed before winter. If much drainage is required the advice of some one experienced in such work should be sought. A plan should be made of the drainage system so that a record will be available after the drains have long since been covered and forgotten. In preparing a map of the drainage system it is good policy to map the water system at the same time.

Often courses are built on land where only short lines of tile here and there are needed. Open ditches can usually be provided to take