There is plenty of evidence of careful planning in the architecture of this recently rebuilt 13th green at Inverness.

As an illustration of a green so situated naturally, and protected that its sporting qualities are as they should be without being unfair, I submit the picture of the Eighteenth green at Inverness.

While the men that I have employed to do the actual labor have always been the best I could get, everything in the way of new construction has been done under my personal supervision. It is very difficult to get men who can visualize a completed green from blueprints. I have often had to do a "sample part" of the work myself and then watch closely all shaping of a green to make sure that it fulfilled my ideas. While there are many opportunities to give variety to green construction, especially if as many natural locations exist as at Inverness, there are certain fundamental principles that must be adhered to.

I have always avoided trickiness in construction. High humps upon a green that deflect a finely pitched shot into a pit nearby is very unfair and hence bad construction. As a basic principle, all greens should hold a properly played shot, especially one that is *up*, for the old saying "never up, never in," must not be discouraged. A green that begins to slope down-hill so that a player dare not hit his approach shot boldly for fear that after it has passed the hole a few feet, it is going to speed up through gravity by reason of a down slope and end up in tall grass at the back of the green is bad construction, particularly on 460 or 470-yard holes. There are no such greens at Inverness.

During recent years I have relocated and so rebuilt No. 2 (this year) and No. 13 (in 1928), and made fundamental changes in the pits guarding Seventeen and Two. I hope and believe that all of these will be appreciated next year, when our visitors come to the National Open. Many of them were here in 1920 and, no doubt, will not these changes, which show the way a good American course grows.

Some Physical Properties of the Soil

By J. S. JOFFE

(Rutgers University Short Course)

PHYSICALLY considering, a soil is a mass of solid particles differing in their size, shape and nature. Assuming the particles to be spheres, we may see how the arrangement of those and their size will influence the pore space in the soil. The larger the particles the less pore space and vice versa. Sandy soils may have 20% pore space and gravelly soils may have even as low as 10% pore space. Most cultivated soils range between 35 and 50% of pore space. The proportion of interspace in a soil determines both the volume of air it will hold and the amount of water it is capable of taking in. The size of the pore space determines the rapidity with which the water will flow through the soil.

The size of the particles has another important function in the soil. It determines the extent of the internal surface of the soil. The retentive power of soils for water is determined primarily by the extent of their internal surface. The plant food ingredients are absorbed by the surface of the particles or by forces governing surface reactions.

The soil particles, large or small—from gravel to clay—do not exist in the soil as independent units. The various particles are intermingled forming what we know as the type of soil. The individual particles within each type also coalesce, forming typical aggregates, and this property of the soil is known as structure. The form and shape of the structure of aggregates differ for various soils. There may be a crumbly structure, granular, nutty, prismatic, columnar, and the shape of this varies with the type of soil, condition of moisture and temperature. Soil structure is intimately related to soil texture. The texture in turn determines the weight of the soil.

The specific gravity of soils will differ according to the composition of the soil. As there are not many common minerals more than three times as heavy as water and not many lighter than 2.5 times as heavy, the specific gravity of soil grains will lie between these two figures. The presence of humus will decrease the specific gravity. The following gives the specific gravity of soil constituents: water, 1.0; humus, 1.2-1.5; clay, 2.5; quartz, 2.62; feldspar, 2.5-2.8; talc, 2.6-2.7; calcite, 2.75; dolomite, 2.8-3.0; mica, 2.8-3.2. In soils we do not determine the true specific gravity but the apparent specific gravity, taking the volume of the soil as it is with the pore space in it. The apparent specific gravity of an average soil is about 1.2 and a cubic foot of it will weigh about 75 pounds; a cubic foot of water weighs 62.32 pounds. A sandy soil consisting of a lot of quartz will weigh more than a clay soil which has in its makeup the substance with a lower specific gravity.

Another important physical aspect of soil properties is the moisture regime. Three forms of water may be considered: 1. hygroscopic, 2. molecular, 3. gravitational.

Capillary Movement

The porosity of the soil is responsible for much of the most important phenomena in the moisture of the soil, namely, the capillary movement. Capillary moisture moves faster in wet soils than in dry soils. Thus when a soil is dry at the surface, small rains induce more rapid moisture evaporation from the lower layers by establishing the capillary contacts. Mulching of soil after small rains serves the purpose of breaking up capillary rise. Superficial sprinkling of lawns or any grass sod will do the same thing as small rains do to soils, namely, exhaust the moisture from the lower layers.

The fate of the water coming in the form of rain is extremely interesting. Part of it is absorbed by the soil, part goes down to the ground waters and the rest is shed from the surface known as "surface run-off." The soil type will determine the disposal of the rain in the relative proportion of the respective portions. A sandy soil will allow a larger percolation portion as compared with a clay soil; the surface run-off will be higher on a clay soil, etc.

The depth of the ground water, or as we know it, the water table, is an important consideration in the study of soil moisture. The level of the water table is not constant, especially in humid regions. Deep rooting plants will do well on a soil with a high water table. The grasses as a rule do well on such soil.

Another important physical property of the soil is its temperature. The temperature of the soil varies with the periodical fluctuation of the sun's radiation, fluctuations of the air, temperature; it depends on the heat properties of the soil constituents, heat capacity of soil, color, structure, texture, exposure, etc.

An essential feature of any soil is the capacity to hold air and other gases, and permit their circulation.

The quality and quantity of soil air differ from that just above it. There is more carbon dioxide in the soil air, a little less oxygen. The composition of the soil and the process taking place in it will determine to a certain extent the quality and quantity of gases.

Among other physical properties of the soil mention should be made of its stickiness—forces with which the particles are held together, plasticity—the property to maintain a definite form. These are determined primarily by the relative proportion of the various soil fractions.

The physical properties of the soil may be summarized as those which control the moisture, air and temperature of the soil, or as we call it, the aero-hydro-thermal condition of the soil.