There is one set of conditions where wells will always fail, and that is obviously where there is no ground-water supply. This may result from five principal causes:—

1. The available rainfall is deficient or is entirely lost by surface run-off and evaporation, leaving nothing for percolation beyond the reach of plant roots.

2. Lack of absorption capacity of the soil or surface. This may be due to the existence of impervious rocks or clay at the surface.

3. Lack of adequate transmission capacity. Owing to sparseness of fissures in rock or fineness of soil materials, it may be impossible for the soil to transmit enough water to deep-seated water-beds to furnish a permanent adequate supply for wells.

4. Lack of storage capacity. The infiltration or supply to the water-beds being intermittent, the yield of the wells will also fail unless the water-beds have enough storage capacity to provide water supply during periods of insufficient infiltration.

5. Inability of the water-bearing material to yield its supply to the well. This is a common cause of difficulty in securing adequate water supply from very fine sands and clays. These materials commonly contain from 25 to 40 per cent. of voids which are filled with water, but only a little of which will flow into a well because a large portion of the water is permanently held in the fine pores by capillary attraction and the artesian flow or transmission of water through such materials is exceedingly slight. It is evidence that none of these causes exists to prevent obtaining a satisfactory well in a given locality when it is known that there are several successful wells, all obtaining satisfactory water supplies under the same conditions as those which apparently exist where the new well is to be drilled. If, now, most of the wells in a certain locality are successful, and it is known that there is a water horizon generally existing in the place where a new well is desired, the presumption is very strong that a successful well will be obtained at about the same depth as in the other wells in the vicinity.

Failures not infrequently occur under just these conditions. It is also the existence of such failures and the existence of marked success where failure is the general rule which have created in a marked degree the popular feeling that there is great mystery, if not something supernatural, about the occurrence of underground water.

It seems certain that failures to secure water supply in wells drilled under the conditions described, i.e., where there are other successful wells in the vicinity and where there is known to be a generally diffused ground-water horizon, are due to only a few causes, and can readily be explained in most cases from evidence either existing on the surface, in railroad cuts or other excavations, or obtainable directly from the records of wells drilled.

In analyzing the causes of such failures, it is convenient to consider three cases:—

1. Where ground-water is generally diffused through the pores of the water-bearing medium, usually sand or sandstone.

2. Where the ground-water is contained in fissures in more or less fractured rock, such as granite, trap rock, or shale.

3. Where the only underground water available generally is that contained in solution channels or other definite open passages, such as often occur along fault lines.

Discussing these cases in their inverse order, it may be said that where water is only contained in solution channels or definite passages along fault lines, the chances of success in any given bore made at random are very small. The presence of solution channels in limestone may, however, sometimes be detected at the surface by the presence of sink holes, and their presence would naturally be expected from the existence of caves, and from brooks or springs issuing from limestone strata and in general where limestone is prevalent throughout the region. The existence of fault lines is often apparent at the surface, where they may be traced by anyone, and where not so apparent, they can often be traced by geologists. We are here presuming that wells have been generally successful in the locality. This could be true where the source of water supply is in solution channels or along fault lines only when the existing wells are located along such lines. The natural location for new wells would be in line with existing wells. They will fail where, as is often the case, the direction of the fault line or solution channel suddenly changes or comes to an abrupt end.

In the first two cases mentioned, where wells are generally successful, it may be said that there are five, and only five, principal reasons why a new well in the same locality put down to the depth at which ground-water is supposed to exist should be a failure:—

1. The existence of a pocket or included mass of non-water-bearing materials.

2. Local pinching out of the water beds or water-bearing strata by thickening or interfoliation by overlying and underlying non-water-bearing beds.

3. Termination of the water beds by nonconformity.

4. Termination of the water-bearing beds by faults or trap dykes.

5. The failure of the well to strike a fissure in cases where the water is contained in rock fissures.

OPERATING AND TEST DATA FOR FUEL-OIL ENGINE AND GENERATOR.

The great economy that is possible to effect by the employment of the fuel-oil engine in electric light and power service is strikingly shown in the report on the performance of such an engine in the plant of the Goodland (Kan.) Light and Power Company, as outlined by R. B. White in the Electrical World, Vol. 65, No. 26. The oil engine is 60-horse-power, of the two-stroke semi-Diesel type for crude or fuel-oil, belted from the fly-wheel to a 75-kilowatt, three-phase, 2300-volt, sixty-cycle generator, operating single-phase at 2200 volts. This unit operates in parallel with a 100-kilowatt, single-phase generator driven by a 105-horse-power single-cylinder engine. The steam is generated from coal costing $3.25 per ton delivered. The oil engine uses Kansas fuel-oil costing 2.3 cents per gallon. Before installing the oil engine the coal bill was $600 per month, whereas the present coal and oil bill does not exceed $300 per month.

A test section of the pure water conduit, which is to run from Lake Erie to St. Catharines, has been built at Port Colborne, Ont. It is 300 feet long and four feet in diameter.

Last month there were five large factories under construction in Hamilton, Ont., for the following owners: Proctor-Gamble Company, Dominion Sheet Metal Company, Canadian Horseshoe Company, the Canadian Cartridge Company, and the T. Eaton Company.