streams may have connection with surface sink holes. Cornstalks and other refuse from the surface not infrequently appear in wells drawing water from limestone, and the waters are often muddy after storms. Such occurrences are indications of surface contamination, and the waters should be avoided if possible.

Granite.—Practically no water passes through the body of granite, the movement being mainly along joint or fault planes or through pore spaces in the disintegrated upper portions of weathered granite masses. Polluting matter may reach to considerable distances through joint of fault planes, as is indicated by the fact that the salt water of the ocean finds entrance to some wells located 500 feet, and in places even a quarter of a mile or more, from the shore. It is said that in the deep public well sunk in granite at Atlanta, Ga., sufficient polluting matter entered through a joint struck at 1,160 feet from the surface to render the water unfit for drinking.

Protection from Surface Wash.—Many open wells are exposed to the same danger of pollution from surface wash as springs, and the same methods of protection should be used. A water-tight curb should be raised a few inches or a foot above the level of the surrounding surface and the earth banked around it, with a slope away from the well. This curb quickly deflects the water and prevents it from collecting and soaking through the ground into the well.

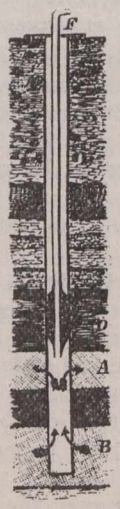

Fig. 5—Section of Well Showing Loss by Leakage from One Deep Bed into Another.

Protection from Stock.—The chief means in which wells become polluted by stock is through seepage from the surface. Watering troughs are commonly placed close to wells, and usually in such places the hoofs of the animals soon wear holes in which the rain water and more or less of the animal excrement collect and soak into the ground, finally reaching the well. To prevent this contamination the watering trough should be placed as far away from the well as possible, the water being conducted to it by pipes. A well in an open pasture, if it is to be used at all by human beings for drinking water, should be surrounded by a fence at least 20 feet away.

Protection from Pump Drippings.—The drip from pumps is a very common and dangerous source of pollution. In the greater proportion of dug wells provided with pumps the well is covered with boards or planks laid or nailed over the top. No matter how carefully these platforms are constructed, cracks through which water can enter almost invariably exist, and it is a common occurrence to have the water dropping or trickling back into the well whenever any is spilled in pumping. The danger of this will be understood when it is recalled that those stepping upon the platform to pump may have just come from the barnyard or from manured fields, bringing with them on their shoes more or less filth, part of which is left on the planking and washed into the well by dripping water from the pump or by the next rain. The wooden platform should be replaced by a water-tight cover made of iron, cement, or other impervious material. Cement covers are coming into use in many localities and afford ideal protection.

Protection from Small Animals.—An ever-present cause of pollution in open wells and wells insufficiently protected by coverings is the entrance of small animals. It is a common thing for snakes, toads, mice, and even rabbits, to penetrate through crevices and to fall into the well, especially in dry seasons, when the animals are compelled to make desperate attempts to reach water. The remedy is an impervious well-cover fitted tightly to the curb.

Protection from Dust.—Dust is usually less dangerous than other sources of pollution, but in dry seasons, when dirt from the street or barnyard is being blown about, it may become of considerable amount and danger. It is not uncommon to find several inches of black, foul-smelling silt in the bottom of a well on cleaning, even though it may have been cleaned only a year or two before. The dust may be kept out by water-tight coverings such as are used to keep out pump drippings.

Increasing the Yield.—The methods of increasing the yield of wells vary according to whether the well is of the dug or drilled type, and whether the existing supply has or has not materially decreased from the original supply. An originally inadequate yield commonly results from insufficient supplies in the water-bearing rock or from the slowness with which the supplies are given up. A decreased yield may be due to some defect in the well itself.

Remedy for Insufficient Supplies.—Ordinary clay and the denser varieties of pebbly and boulder clay or till usually contain but little water, and this little is often largely in the form of interstitial water held in the body of the material and given up slowly to a well by general seepage. Under such conditions the amount entering the well is often more or less proportional to the area of surface exposed in the wall. This area varies with the diameter of the well; thus, three times as much surface will be exposed in a given height of wall in a 6-inch well as in a 2-inch well and six times as much in a 3-foot as in a 6-in well. To give a large yield a large-diameter well is very desirable in materials of the character mentioned.

Large wells are also desirable in rocks in which the water occurs in a similar manner; that is, in pores rather than in open passages. In general, however, if water is yielded at all by the rocks, it is given up more readily than by clays, hence a large bore is less necessary. This is fortunate, for the range of size in rock wells is usually rather scant, owing to the fact that most rock wells are of the drilled type. Where the water occurs in bedding or joint planes the diameter is of still less importance, as the entrance of the water is localized and is relatively free. Large diameters, nevertheless, increase materially the likelihood of striking an opening. In the oil regions the increase of the diameter of a bore 2 inches by reaming has been known to open pools not encountered in the original hole, and a similar result is possible in water wells.

The depth of dug wells in material in which the amount of water is relatively small is also important, for increase in depth increases the storage space in which the water can collect during periods when the well is not in use, thereby greatly adding to its total capacity.