so have been made. Certainly free lime, in the sense in which it has generally been understood, cannot produce the blowing or disruption which occurs with unsound cement, because an addition of free lime, in the form of ignited calcium oxide, has the effect of reducing expansion by inducing the hydration of particles of hard clinker grit, in the same way that ammonia or ammonium carbonate does so.

The improvement in soundness, brought about by the exposure of cement to a damp atmosphere, lends some apparent support to the contention that free lime is thereby slaked and rendered harmless; but it is rather difficult to understand how the small amount of moisture absorbed from the air penetrates the particles and slakes the free lime when the enormously greater quantity of water used in gauging the cement fails to touch it. Furthermore, unsound cement stored for some time in airtight receptacles, in which, presumably, no slaking of free lime can occur, becomes perfectly sound.

Exposure of cement to air for a few days sometimes results in an increase in the amount of expansion, as tested by the Le Châtelier method, and this increase is nearly always proportionate to the amount of aëration undergone—i.e., the thinner the layer in which the cement is laid out, the greater the increase of expansion.

This phenomenon was pointed out by me in an article published in 1907, and was the subject of a paper presented to this institute by Mr. Butler in 1910. The facts are therefore well authenticated, and they are directly opposed to the theory that expansion of cement is caused by free lime.

We know very little yet of the properties of lime in a state of solid solution. It is stated to be crystalline and to hydrate slowly; but if the solid solution theory be correct, crystalline free lime is present in considerable quantity in all Portland cements, whether sound or unsound, and it has not been satisfactorily explained why the lime hydrates without expansion in one cement, but does so with destructive force in another.

It is also well known that a low-limed cement is often more unsound than a high-limed cement, which, again, is antagonistic to the free lime theory.

My own view is that unsoundness in cement is probably due to the presence of an abnormal silicate, perhaps dicalcium silicate, which is an unstable compound and slowly disintegrates with an increase in volume. The phenomenon of "creeping clinker," known to cement makers, is an illustration of the disintegration, with increased volume, of dicalcium silicate, which is formed when clinker contains an insufficiency of lime; and this or a similar compound is most likely to be found in unskilfully made cement in which the proportions of lime, silica, and alumina are not present in correct combining weights, or when the temperature of burning is insufficiently high to induce the formation of those silicates and aluminates which constitute true Portland cement.

A new departure on the part of the government of Great Britain recently, and one which caused great comment, was the request made to four private firms to tender for the construction of submarines of a new type, and concerning which the greatest secrecy has been maintained. The new type is said to be as far in advance of previous submarines as the Dreadnought is over the pre-Dreadnoughts. It is said to have a speed of over twenty knots, with a wide radius of action. It will be equipped with wireless; its guns will be superior to the armament of the present destroyers; and it is expected to revolutionize naval warfare.

ECONOMIC CONDUIT LOCATION.

THE paper entitled "Economic Canal Location in Uniform Countries," by Lyman E. Bishop, Assoc. M.Am.Soc.C.E., which appeared in Vol. 74, Transactions Am. Soc. C.E., contains a series of interesting and useful diagrams, by the use of which the locating engineer can quickly determine the economic centre line cut for any particular canal section for any slope of ground. The subject is followed up, particularly in several of its phases, by C. E. Hickok, Assoc.M.Am. Soc.C.E., in a paper appearing in the December Proceedings of the Society, who claims that every conduit, unless it is in a country of uniform topography, must change at certain points from one type of construction to another, in order to be built economically and safely. It is rarely that a conduit of any considerable length can consist entirely of canal section, but rather it must change to flumes, siphons, pipes, bridge flumes, or tunnels, as the conditions demand. The points of change are determined,

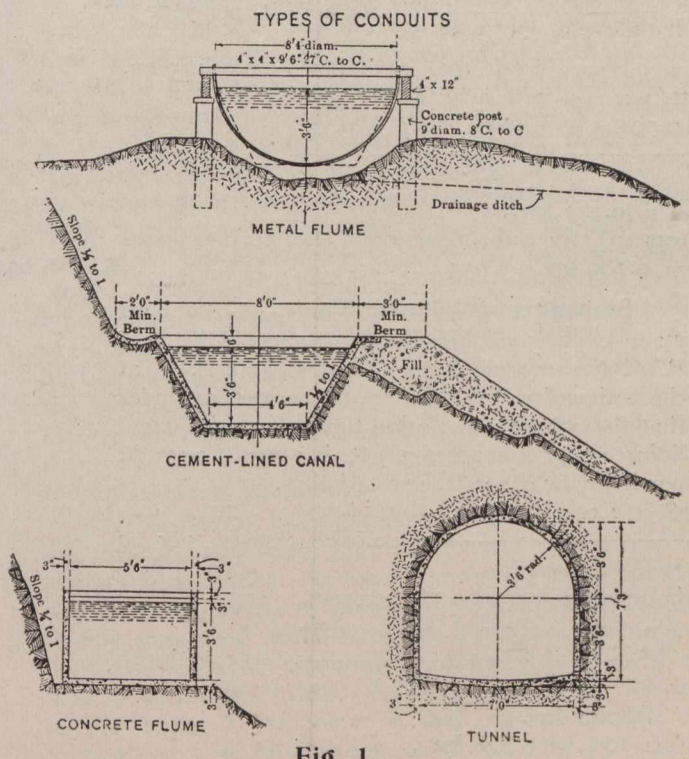

Fig. 1.

not only by the slope of the ground, the nature of the material encountered, and certain local conditions, but by economic considerations as well.

In making conduit locations, from time to time, the writer has evolved a diagram, giving the equivalent lengths, from an economic standpoint, of various types of conduit, which has been of considerable value. For instance, when the locator comes to a point where he must decide whether to tunnel through a ridge or follow the grade around with a canal, he measures the length of the two possible routes, and, by an inspection of the diagram, comes to a ready decision. This not only eliminates considerable loss of time, but, if the diagram has been properly constructed, assures a proper and complete comparison between the two alternatives as to first cost, depreciation, head-loss values, evaporation and seepage loss values, interest, taxes, inspection, and repairs.

For purposes of illustration assume a case where the project under consideration is to be used for irrigation