Table IV.—Action of Magnesium Sulphate on Cement Mortars Containing Barium Compounds.

Age in 1 per cent. Solution of Magnesium Sulphate	Strength, lb. per sq. in. of briquettes containing— 2 per cent. of Barium Chloride	2 per cent. of Barium Carbonate	5 per cent. of Barium Carbonate
0 days*	181	115	166
7 days	...	221	257
28 days	213	246	346
3 months	306	311	346
6 months	265	204	274
1 year	146	Disintegrated	Disintegrated

* The briquettes were aged 14 days in air before immersion.

Some years ago an English chemist suggested the use of finely ground, burnt red brick as an admixture for concrete which was to be used in sea-water. After reading this paper it occurred to me that the resistance to sea-water claimed for high-iron cements might be due to the presence of oxide of iron in the cement. I therefore had sand briquettes made up containing oxide of iron in various forms and conditions, namely, red or ferric oxide, magnetic oxide of iron, venetian red (an impure oxide of iron made from low grade iron ores, so-called "paint ores" of the Lehigh district), and finely ground red brick, using of these 5 per cent. of the weight of the cement in each case and placing the briquettes in a 1-per cent. solution of the magnesium sulphate. The results are given in Table V. As will be seen, the additions of iron compounds are in no way beneficial to cements to be employed in sea-water.

Table V.—Action of Magnesium Sulphate on Cement Mortars Containing Iron Oxides, Etc.

Age in 1 per cent. Solution of Magnesium Sulphate	Tensile Strength, lb. per sq. in., of briquettes containing 5 per cent. of— Ferric Oxide	Magnetic Oxide	Venetian Red	Brick Dust
0 days*	218	225	165	170
7 days	275	280	225	220
28 days	310	340	300	275
3 months	355	340	345	310
6 months	310	280	215	205
1 year	125	105	Disintegrated	Disintegrated

* The briquettes were aged 14 days in air before immersion.

I next tried waterproofing the mortar on the theory that if the circulation of water through the pores of the mortar could be stopped no chemical action could take place. I employed for this purpose both a high-calcium and a magnesium-hydrated lime, road oil (as recommended by Page), a mixture of silicate of soda solution and fish oil (a well-known waterproofing compound), and lime soap (the basis of many waterproofing compounds). I also tried dipping the briquettes first in a hot solution of soap and then in one of alum (Sylvester's Process). The results of the tests of sand briquettes made from these mixtures and stored in magnesium sulphate solution (10 grams to the liter) are given in Table VI.

Table VI.—Action of Magnesium Sulphate Solution on So-Called Waterproofed Mortars.

Age in 1 per cent. Solution of Magsium Sulphate	Tensile Strength, lb. per sq. in., of briquettes containing— 15 per cent. of Hydrated Lime (Calcium)	15 per cent. of Hydrated Lime (Magnesian)	10 per cent. of Road Oil	2 per cent. of Lime Soap	2 per cent. of of Oil Silicate Soda	Treated with Alum and Soap
0 days*	215	215	165	185	160	220
7 days	215	225	200	210	200	235
8 days	315	320	210	250	245	275
23 months	245	260	260	275	260	265
6 months	200	245	210	230	225	215
1 year	120	105	140	180	165	185

* The briquettes were aged 14 days in air before immersion.

It will be noted that, while the disintegration is evidently taking place in these test pieces, all of these compounds seem to arrest it to some extent at any rate, and in the case of the lime soap and Sylvester Process this is quite marked.

I also investigated the action of magnesium-sulphate solution on cements high in silica. For this purpose samples of commercial cement, one high in silica and low in alumina and one low in silica and high in alumina, were selected; sand briquettes were made of these and immersed in a solution of magnesium sulphate containing 20 grams to the liter, or practically a 2-per cent. solution. The cements selected had the following analysis:—

	Low-Alumina Cement	High-Alumina Cement
Silica, per cent.	23.24	19.86
Iron Oxide, per cent.	2.25	2.56
Alumina, per cent.	5.03	7.60
Lime, per cent.	63.55	63.12
Magnesia, per cent.	3.05	3.10
Sulphur trioxide, per cent.	1.51	1.66

As will be seen from Table VII., the low-alumina cement resists the action of magnesium sulphate much better than the high-alumina one.

Table VII.—Action of Magnesium Sulphate Solution on High and Low-Alumina Cements.

Age in 2 per cent. Solution of Magnesium Sulphate	Tensile Strength lb. per sq. in., of High-Alumina Cement	Low-Alumina Cement
0 days*	242	225
7 days	318	307
28 days	404	430
3 months	402	476
6 months	230	472
1 year	Disintegrated	500
2 years	...	425

* The briquettes were aged 14 days in air before immersion.

In the above experiments, both cements were commercial cements; but the high-alumina cement when received was not quite so finely ground as the other one, so it was ground to practically the same degree of fineness in a small jar mill (or to 86.2 per cent. passing the No. 200 sieve), so that the fineness of the two samples might in no way influence the results. Both these sements were made from cement rock and limestone.

In connection with the use of concrete for mine props, where it is often exposed to the action of dilute solutions of sulphuric acid, the following experiment was tried. Sand briquettes were allowed to harden 28 days and then were placed in a solution containing 250 grains of sulphuric acid (H_2SO_4) to the gallon. The solution was changed frequently and the briquettes broken at regular intervals. The disintegration of concrete by such acid water is shown by the following:—

Age in Solution	0 days	7 days	28 days	3 mos.	6 mos.	1 year
Tensile Strength, lb.	226	299	300	280	176	Disintegrated

Several years ago the question of the action of oil on concrete was brought up at one of the meetings of this society in connection with a paper by Professor Carpenter. In his experiments, oil was mixed with the concrete. In the discussion which followed the reading of the paper, a number of gentlemen suggested that what was needed most was information relative to the action of oil on concrete which had already hardened, in view of the employment of concrete for machinery bearings, engine room and factory floors, etc., where it is subjected after being fully hardened to the oil which leaks from the bearings of the machinery. I went home from this meeting and had a number of sand briquettes made and allowed them to harden two weeks in air. These were stored in air, in engine oil, in cylinder oil, and in black oil, and broken at stated periods. The results are given in Table VIII.

It will be noted that the engine oil and the cylinder oil have practically no effect upon concrete. One would think that as the latter has a considerable proportion of