at one and the same time. To-day we have no tool, no substance which will accomplish this double feat. Mr. King, dwelling on the diamond point, says, "its extensive use is the great distinction between the antique and modern work."

SOME EXPERIMENTS IN BURNING SLUDGE INTO CEMENT.

Portland cement is manufactured from chalk or limestone and clay. The component parts of these materials vary very slightly, and therefore the manufacture is nearly constant. The average analysis of five large manufactories gives the following results, namely, lime, 56.21 per cent; silica 24.44 per cent; iron, alumina, 12 1 per cent.

The manufacture of Portland cement from sewage is much more precarious. Sewage, according to my experience, varies in every place and during every hour, and consequently has to be carefully watched in order that the requisite quantity of milk of lime may be added. At Burnley, on certain days, large quantities of dye water come down, on other days butchers' refuse, and once or twice we have observed the sewers full of coal tar and oily refuse. All these facts have to be carefully observed, and only after careful experiments can the quantity of lime necessary to precipitate the sewage be determined. The resultant sludge at Burnley on an average only contains 46 to 50 per cent of lime, and therefore before it is fit to be burnt into Portland cement clinker, more lime has to be added. This is done after the supernatant water has been run off the sludge deposited in the tanks. The sludge has afterwards to be passed through a pug-mill in order that a uniform compound may be obtained.

At Birmingham, where Portland cement was also made, the sewage is so capricious that a uniform manufacture could not be guaranteed. This is accounted for by the fact that at certain times very large quantities of acid from the hardware manufactories of the town are poured into the sewers.

At Portsmouth, where I have studied the sewage, which has wholly water-closet and house drainage, there is little or nothing to interfere with the manufacture of a high class Portland cement. I believe the same remark would apply to the lower Thames valley sewage. The sewage requires only a small quantity of lime to defecate it; 16 grains of quicklime per gallon is ample. The sludge I have found generally contains from 58 to 60 per cent of lime, and therefore no fresh lime would have to be added. The fact that at Portsmouth the storm-water is partially kept out of the sewers is also greatly in favor of the manufacture of good cement. And in places where the separate system is in force, and where the proportion of water-closets is large, it would be, perhaps, worth while to allow the finely suspended organic matter to subside before liming, and to treat the organic matter described in General Scott's patent.

The sludge resulting from limed sewage may also be burnt at a lower temperature than that necessary to produce Portland clinker, and be re-used to precipitate the sewage. After this has been done several times the lime becomes rich in phosphates, and may be profitably sold as a first-class agricultural lime.

As a result of my experience I have arrived at the following conclusions:—

a. The sewage of every town should be carefully watched and experimented on before any plans or estimates are made.

b. The storm-water should, if possible, be kept out of the sewers.

c. A paved town is more favorable to cement manufacture than an unpaved one.

d. That manufacturing refuse, except acids, does not materially interfere with cement manufacture.

In conclusion, I may state that the cement now being made at Burnley is much improved in quality since the manufacture began, and much has been sold. The latest tests give excellent results, Mr. Deacon, borough engineer of Liverpool, reports the tensile strain, of 695 pounds on the 1½ inch square, and that the cement passed through a sieve of 50 meshes to the inch, leaving only 7 per cent of residue. The latest test at Burnley gives 398 pounds.

A portion of a sea-wall at Portsmouth has been built with it, and it has stood this test remarkably well.

Much has been learnt since the process was first started at Burnley, and it may be fairly expected that towns will obtain purification, and at the same time will recover the greater part of the cost of so doing, by adopting this process.

CURE FOR BURNS.—An iron-foundry man recommends powdered pinewood charcoal as "a never-failing, speedy remedy" for burns and scalds.

THE FLEXIBLE SHAFT.

Although great strides have been made during the past 10 years in all kinds of machinery, the expert recognizes most of them as extensions and developments of known ideas and methods. The principles involved in the flexible shaft are, however, radically different from the principles involved in other machinery. The different stages of its growth towards perfection were so unobserved by the world at large, that when exhibited at the Centennial exhibition, it excited the greatest astonishment of every beholder. Almost all machinery is characterized by fixity in certain places of motion. The whole value of a turning lathe consists in the maintenance of its centres in a true line, and in all reciprocating machine tools, the moving portions of the mechanism are confined to fixed lines and planes. But here is a device which sets at naught the transmission of rotary motion through straight lines, and conveys it through through curves varied at the will of the operator. It upsets all our ideas of rigidity. The first "flxexible shaft" was a simple coil of wire, used as a universal joint in sheep-shearing machines, dental and a limited number of light power machines. Flexibility was obtained at a great sacrifice of strength, and the coil therefore made inconveniently large.

Where primitive motion was desirable the angle of torsion was too great, to correct which defect a coil of wire was wound on a center or flexible material. This was an improvement, but only to the extent of the resistance to compression offered by the filling material. The next step was an important one and consisted in two concentric coils, wound in opposite directions, instead of a single coil. By this arrangement the tendency of the outer coil to contract is met by an equal effort of the inner coil to *expand*. Flexibility was lost, however, since it required more effort to bend two coils than one. It could not be used on any but light power machines on account of its liability to kink or twist out of line, and double up into twisted loops. The shaft, too, when running at a high rate of speed, vibrated in a very curious manner, dividing into equi-distant nodes like the string of a musical instrument, and thus interfering with the proper functions of the working tool, giving it a tremulous motion im possible to control. The defects were finally overcome by enclosing the revolving shaft in a flexible *stationary* sheath or case, and at the same time the carrying power of the shaft itself was increased by making it solid all the way through, in the sense that wire rope is solid, the sheath enabling an indefinite number of bearings to be given the revolving core, preventing all tendency to kink or vibrate. As now constructed the flexible shaft is made up of a *core*, a *case* and appropriate fittings by which the two are joined, rotary motion communicated at one end of the shaft and delivered at the other.

The core is composed of a series of concentric steel wire coils wound hard on each other, the direction of the pitch changing with each layer. The pitch direction of the outside layer is always such that the latter will tend to contract under strain, the shaft always running one way. The case is made of a hollow coil of square wire, with a slight groove on the outer side. This coil is covered with leather, which is prevented from slipping by the groove in the wire. The inside diameter of the case is slightly larger than that of the core, and the ends are furnished with iron ferrules, to receive the driving pulley and the hand-piece carrying the working tool.

The flexible shaft is not a special tool for a particular purpose, but a connecting link between a given power source and a multitude of tools, and its uses are very varied. It is used in light operations as well as heavier ones, particularly metal drilling. By means of a pair of idler pulleys, mounted one over the other in a weighted frame, and secondly of a pair of pulleys in a swivel frame attached to a hanger adjoining the counter-shaft, the shaft and its drill may be carried at will to any part of the shop.

It reaches into remote corners, and is applied to manifold applications, from drilling, polishing, horse and cattle brushing, morocco finishing, even to boot blacking. A correspondent of the London *Times*, speaking of this shaft, says: "Pharaoh himself could not have been more surprised at see Moses' rod turn to a serpent than we were to see this rope-like affair eating into the planks set on all sides for it to work upon."

Surgery can justly boast of a new conquest; when an eye is severely wounded, the healthy one is in danger of being impaired by "sympathy"; to preserve the good eye, it was hitherto the practice to remove the injured one. Dr. Boucheron has discovered, that by cutting the ciliary nerves, the "sympathy" is stopped, and thus dispenses with the necessity of removing the injured organ. Forty surgeons have thus operated successfully.