

with the lathe, shaping machine, drilling machine, &c., when applied to the manufacture of big guns and other military material.

The principles of sanitation are the same for the military engineer as for the civil engineer, but they have respectively to apply them to widely varying conditions, as will be seen by comparing the problems of water supply and disposal of refuse for an army of 30,000 men spread out for a variable period along, of a front of (say) 15 miles, and that for a similar number of inhabitants occupying permanent dwellings in a city.

Telegraph and telephone work (including wireless telegraphy) are almost exactly similar in their military and civil developments, civil inventions being applicable almost without adaptation to military requirements; but these sciences come in warfare under a large head which may be called "signalling," and include the conveying of signals to a distance by semaphore, waving flags or flashing lights.

Electric lighting has been applied to harbour defence, search lights or fixed beams taking about 25 H. P. to run them, and also to siege operations.

FORTRESS WARFARE FROM A CIVIL ENGINEERING POINT OF VIEW.

To turn from generalities to an actual example of modern warfare, let us imagine a staff of civil engineers, experts in all the branches, placed under the command of the general who is besieging Port Arthur, to give him the benefit of their advice. How can the fortress be reduced? First, the water supply may be cut off, and the railway rendered useless to the besiegers.

The throwing of explosives from a distance is now the work of the artillery, and the preparation of the sites for the guns requires more military knowledge than particularly scientific engineering.

But how to approach the chain of forts that protects the fortress? Can the engineers devise any means to protect the attacking troops from the hail of lead that mows them down in swathes like grass, even at a distance of 600 yards,—can shields be devised light enough to carry and yet impenetrable to bullets? Can any means be devised to cut those terrible wire entanglements? or to divert the electricity with which they are charged?

The fortress must be reduced in six months;—can tunnelling equipment be procured that can drive a tunnel 2,000 yards in that time and so enable a charge of explosive to be placed under a fort? Can any modern methods of excavating be employed? or are the pick and shovel to be the only tools for earthworks?

We can see how essential telegraphs and telephones would be to the conduct of the siege, and how ballooning would have a field of its own; but for the most part the refinements of civil engineer-