

given, when unconfined, a pressure $P' - P = 0.83$ metre of water, corresponding to $Q = 48.5$. In the tin tube of 0.98in. and 1.57in. $P' - P = 0.525$ metre of water, $Q' = Q - AU = 30.6$.

$$\text{Therefore } AU = 17.9 \text{ and } \frac{AU}{Q} = \frac{17.9}{48.5} = 0.37.$$

The amount of heat transformed into work by the disruption of the sides of the tube and by the projection of the fragments varies, moreover, with the nature and size of the tube. Other things being equal, it diminishes with the thickness. Working always with dynamite it was found that with a lead tube of 1.26in. and 1.65in. the portion of the heat absorbed in mechanical work is about 0.44. With a lead tube of 1.18in. and 1.38in. this portion is 0.33. In this experiment, therefore, a little more than a third of the total heat is transformed into work. This is about half of the transformation that the expansion of the hot gases resulting from the explosion of dynamite thoroughly stemmed in a close place would theoretically be able to produce.

Apparent Temperature of Ignition of Mixtures of Firedamp and of Air under the Influence of Explosives.—The experiment-results obtained with dynamite, moreover, allow the calculations—at least, approximately—of the temperature which the gases produced by the detonation of the explosive should possess in order to ignite the mixture of firedamp and air. In fact, since the expansion of the gases produced by the detonation of the dynamite has lost, by communicating it as kinetic energy to the sides of the tube, 0.37 of its quantity of initial heat, it preserves no more than 0.63 of it. By a calculation similar to that used to ascertain the temperature of detonation it is found that the gases, at the moment when the tin tube of 0.98in. and 1.57in. has been shattered, come in contact with the inflammable mixture, they have a temperature of 3,902° Fahr. The mixture not igniting by this contact, it can be said that the apparent temperature of ignition is under the conditions of the experiment above this figure.

After the projection of the tube of 1.18in. and 1.38in. the temperature of the gases should be 4,136° Fahr., but they ignite the firedamp. The apparent temperature of ignition of the mixture of firedamp and air will therefore be, as far as can be judged from purely approximate calculations, between 3,902° and 4,136° Fahr., or about 3,992° Fahr. If the same calculation is made for blasting-gelatine fired in a tin tube of 0.98in. and 1.57in. it is found that the temperature of the gases after bursting the sides of the tube should be about 4,352° Fahr. These gases consequently ignite the firedamp mixture. It must be recollected that the high value of the apparent temperature of ignition of firedamp deduced from observations is due—at least, in great part—to the considerable delay of the ignition displayed by firedamp mixtures, and to the very rapid expansion of the gases resulting from the detonation of the explosives, which causes an extremely quick cooling. It consequently applies only to the particular experimental conditions under which it was obtained.

Explosion Amongst Water.—Trials were made as to what effect can be attributed to the Settle cartridges formed, as previously mentioned, of an impermeable paper tube, closed at the bottom, which can be filled with water, and in the midst of which the explosive is placed. This tube is intended to be placed in the shot-hole which it fills. It has a greater diameter than that of the explosive cartridge, which is isolated from the sides by metal projections. It was found on suspending the Settle cartridge in the midst of a firedamp mixture, and placing a cartridge of powder in the midst of water, that the detonation of the latter caused the ignition of the external gas. When powder was replaced by a cartridge of 772gr. of dynamite the same effect was produced one in two trials.

Variation of Work developed by the Gases of the Explosion with Density of Charging.—Tests were made as to what effect an empty space left between the explosive and the tube could produce, or, to put it more generally, the variation—the variation of what may be called the density of charging: that is to say, the proportion between the weight of the explosive and the volume which it occupies in the tube. With this object, 401gr. of dynamite were rammed into a tube of thin glass of an external diameter less than 1in., and in this little tube was placed inside a tin tube of 0.98in. and 1.57in., closed at one end, and above a plug of clay 2in. thick; the upper part of the tin tube was stemmed from 4in. to 4½in. thick with clay. The method of charging is shown in fig. 10, where t is the internal glass tube filled with dynamite, T the tin tube, A the clay plug, and B the stemming.

Under these conditions the two curves of the variation of pressure are shown by fig. 11. The initial pressure developed by 401gr. of dynamite, detonating unconfined—curve T —may be deduced.

$P' - P = 0.420$ metres of water, whence $Q' = 24.5$. This result is in accordance with the experiment made with 772gr. As to the detonation in the internal tube inside the tin tube, the initial pressure is found to be $P' - P = 0.330$ metres of water, whence $Q'' = 19.3$. By referring to fig. 11: T = curve of pressure for a cartridge of 401gr. of dynamite, detonating unconfined, and E = curve of pressure for a cartridge of 401gr. of dynamite, filling a thin glass tube stemmed inside a tin tube of 0.98in. and 1.57in. Under these new conditions of charging, the quantity of heat, AU , expended in mechanical work is equal to 5.2 calories, and the proportion of this quantity to the total amount of heat given off from the explosion is only $\frac{5.2}{24.5} = 0.21$.

The mechanical efficiency, which with ordinary stemming was about $\frac{1}{5}$, is now no more than $\frac{1}{5}$. This difference can be accounted for by noting that, the density of charging being diminished, the gases of the explosion expand themselves in the tin tube before exerting pressure on its sides and maintaining their temperature, because there has been no work effected. The pressure exercised by the gases on the walls of the tube being less, these sides are projected with less force and acquire less kinetic energy, whence there results a less production of mechanical work. It follows naturally for that reason that the temperature of the gases, after the destruction of the tube, is less reduced, and, in consequence, higher than under the normal conditions of stemming.

Under the preceding conditions the internal glass tube inside the tin tube of 0.98in. and 1.57in., it was found that the temperature of the gases of the explosion, after the mechanical work effected, was equal to 4,568° Fahr. The gases of the explosion which do not ignite firedamp under normal conditions of stemming can therefore ignite it under these new conditions. This has been