above, and for this reason, that as the reservoir of condensed air is commonly very large in proportion to the tube which contains the ball, its density is very little altered by passing through that tube, and consequently the ball is urged all the way by nearly the same force as at the first instant; whereas the volume of the gas arising from inflamed gunpowder is very small in proportion to the barrel of the gun, and by dilating into a comparatively small space as it urges the ball along the barrel or tube is proportionately weakened, and it always acts less and less upon the ball in the tube. Hence it happens that air compressed only ten times into a large receiver will project its ball with a velocity little inferior to gunpowder."

What is here said of air applies with equal force to the gases. Besides, the ignition of the charge of gunpowder is not instantaneous; it is progressive operation, so that the ball when projected by gunpowder is subject, when passing from the breech to the muzzle, first to a constantly increasing, and then to a constantly diminishing force.

It will be interesting to contrast the cost of gunpowder and of the gases. The length of a 68-pounder is 9·49 feet; the effective length is less by the semi-diameter of the bore, which is 8·12 inches —the length is, therefore, 9·11 feet, and the capacity 4·41 feet. As a ton of zinc evolves 1966 cubic feet of the gases under a pressure of ten atmospheres, and as its price varies from £20 to £30, the cost per round of shot, out of a 68-pounder would be as follows, under the following pressures. At—

10	atmospheres	0s.	9d.	at £20—	1s.	4d.	at £30.
20	"	1	9	"	— 2	8	"
40	"	3	7	"	— 5	4	"
60	"	5	4	"	— 8	0	"
80	"	7	2	"	— 10	9	"
100	"	8	2	"	— 13	5	"

Now, if the *Encyclopædia Metropolitana* be correct in saying that air, compressed ten times, will project a ball with a velocity little inferior to gunpowder, surely these gases, when compressed ten times, that is, to a pressure of ten atmospheres, and exploded, ought to rival and surpass gunpowder, as they would, in addition to the force due to the ten atmospheres, impress a force on the projectile, at the moment of its flight, fifteen times that pressure. But when contrasting the cost of the gases as a projectile force, and that of gunpowder, it is safer to be under, rather than over the mark, so then, notwithstanding the *dictum* of the *Encyclopædia Metropolitana*, we will base our calculation on the assumption that the gases condensed 20 times, and developing on their explosion a force equal to 300 atmospheres, will produce effects equal to those of gunpowder; the cost for shot will, as we have just seen, be from 1s. 9d. to 2s. 8d.

The cost of gunpowder varies, of course, with the price of the articles from which it is manufactured; it ranges from one to two shillings per lb. A 68-pounder takes 16 pounds for a charge; the cost per shot is therefore from 16s. to 32s., consequently the gases are by far the cheaper force, for even at 100 atmospheres they would only cost from 8s. 2d. to 13s. 5d., scarcely one-half the price of gunpowder, but at 20 atmospheres they would scarcely be one-tenth of the price.

Gunpowder is deteriorated or destroyed by the absorption of moisture; this could not happen to the gases. This absorption of damp is a constant cause of "great and unknown losses of strength," and a little more or less moisture will alter most materially the accuracy of practice. Attempts to protect gunpowder from moisture are a constant source of heavy outlay, which should be borne in mind when comparing the relative cheapness of the forces, and "no degree of care" can altogether preserve it from receiving some injury. (Sir H. Douglas.)

Then the force impressed upon the projectile might be increased *ad libitum*. This cannot be done with gunpowder, for if the charge be increased beyond a certain point, a diminution of force results, as part of the powder is shot away unignited, and the powder ignited acts for a shorter space on the ball, but in the electric-gas gun the pressure may be raised to any point in the gas generator so as to impress the required force upon the projectile; thus, if it was found that a 100-pounder, propelled by a force equal to that of gunpowder had no effect upon an iron-plated vessel, the force might be doubled or trebled until the desired result was achieved! indeed, it is probable that these weapons would settle the question of armour-plates, because if, as Mr. Scott Russell holds, the thickness of the plates cannot be usefully increased beyond 4½ inches, as soon as a weapon is constructed of sufficient force to destroy this armour, it will cease to be a protection, and will only insure the sinking or capsizing of the unlucky vessel it was intended to protect, like the knights of former days, whose armour at last became so heavy that, if they chanced to be unhorsed, they were compelled to lie prone, unable either to renew the fight, or to consult their safety by a retreat.

It may be observed that it would be difficult, when the firing proceeded from works in any way extensive, or from masked batteries, for an enemy to discover the precise point where one of these weapons which threw the projectiles was situated, as there would be smoke and no report (for a vacuum would be formed by the explosion of the gases). In most cases this would prove of signal advantage, among others—as not affording a mark for the shot of the enemy, should he seek to disable the weapon. Besides, the absence of smoke would not interfere with the aim of other weapons, and the absence of noise would enable the orders given by those in command to be distinctly heard.

There would be practically no report; the report, such as it would be, could not be heard beyond a few yards—it would be 500 times less than that of a cannon, and 10 times less than that of an air-gun.

When a cannon becomes heated by repeated discharges of gunpowder, the elasticity of the metal of which it is composed is diminished, and the properties of the weapon are impaired. It is probable that rifled cannon (other things being equal) are liable to be more quickly heated than those with a smooth bore, owing to the fact that the ball meets with greater resistance in moving along a rifled bore than a smooth bore, and consequently consumes more time in reaching the muzzle. The barrel of the weapon is therefore subjected for a longer period to the action of the highly heated gases evolved by the ignition of the gunpowder. This result could not arise from the action of the