tiplied by the square of the time = 16 × 9), being at the end of each of these seconds at the points E, F, G, respectively, describing a curved line A, E, F, G, which will continue curving until the projectile strikes an obstacle or reaches the ground and its motion is partially or entirely stopped.*

This curve A, E, F, G, is the one which would be described by the projectile if it was fired through vacuum, that is to say if there was no air. But the air itself, as already said, offers resistance to the projectile's motion and tends to limit it; because the projectile to pass through the air must push apart all the particles of air which are in its way and some of the propelling force which the projectile has received from the explosion of the charge of powder in the gun is expended in doing so. A 24 pr. shot fired from a gun with the usual service charge, met it is stated with a resistance from the air equal to 400 pounds at least and did not in consequence reach 1-5 of the distance it would have done if the resistance of the air had not prevented it, thus again a rifle bullet which would have ranged up to 3,674 yards if there had been no air to oppose its motion, reached only 640 yards † scarcely 1-6 the distance. Referring to Fig. 1, the projectile instead of describing a curve A E F G of Fig. 1, as we supposed it to do when acted upon only by the force of gravity would therefore when acted upon by the resistance of the air describe a curve A E F G entirely different from the first, and would reach the earth at a point much nearer to the gun A, than if the force of gravity was the only force affecting its motion.

---

* This curve in vacuo would be a parabola, *t. e.*, ...tion of a right cone cut by a plane parallel to the side, with lov... ...cities of 200 or 300 feet per second the parabolic theory gives t... ...ably accurate results; the following formula may therefore be found useful in certain cases of practical gunnery, such as high angle fire with mortars and small charges.

Let V = initial velocity.
R = range.
T = time of flight.
a = angle of projection.
g = gravity.
x and y = horizontal and vertical co-ordinates.

The equation of the trajectory or path of shot.

$$\text{Is } y = x \tan a - \frac{g\, x^2}{2\, V^2 \cos^2 a} \quad (1)$$

$$R = \frac{V^2 \sin 2a}{g} \quad (2)$$

$$T = \tfrac{1}{4} \sqrt{R \tan a} \quad (3)$$

† Experiments in France.