at twelve feet distance from the hole in every direction. Yet it is very sensibly louder when the hearer is in the straight line drawn from the sonorous body through the hole. A person can judge of the direction of the sounding body with tolerable exactness. Cannon discharged from the different sides of a ship are very easily distinguished, which should not he the case by the Newtonian theory ; for in this the two pulses on the ear should have no sensible difference.

The most important fact for our purpose is this: an echo from a small plane surface in the midst of an open field is not heard, unless we stand in such a situation that the angle of reflected sound may be equal to that of inci­dence. But by the usual theory of undulations, this small surface should become the centre of a new undulation, which should spread in all directions. If we may make an analogous experiment on watery undulations, by placing a small flat surface so as to project a little above the water, and then drop in a small pebble at a distance, so as to raise one circular wave, we shall observe, that when this wave arrives at the projecting plane, it is disturbed by it, and this disturbance spreads from it on all sides. It is in­deed sensibly stronger in that line which is drawn from it at equal angles with the line drawn to the place where the pebble was dropped. But in the case of sound, it is a fact, that if we go to a very small distance on either side of the line of reflection, we shall hear nothing.

Here then is a fact, that whatever may be the nature of the elastic undulations, sounds are reflected from a small plane in the same manner as light. We may avail ourselves of this fact as a mean for enforcing sound, though we can­not explain it in a satisfactory manner. We should expect from it an effect similar to the hearing of the original sound along with another original sound coming from the place from which this reflected sound diverges. If therefore the reflected sound or echo arrives at the car in the same in­stant with the original sound, the effect will be doubled; or at least it will be the same with two simultaneous original sounds. Now we know that this is in some sense equivalent to a stronger sound ; for it is a fact, that a number of voices uttering the same or equal sounds is heard at a much greater distance than a single voice. How this happens, we cannot perhaps explain by mechanical laws, or assign the exact proportion in which ten voices exceed the effect of one voice ; or the proportion of the distances at which they seem equally loud. We may therefore, for the pre­sent, suppose that two equal voices at the same distance are twice as loud, three voices three times as loud, &c. There­fore, if, by means of a speaking trumpet, we can make ten equal echoes arrive at the ear at the same moment, we may suppose its effect to be to increase the audibility ten times; and we may express this shortly by calling the sound ten times louder or more intense.

But we cannot do this precisely. We cannot by any contrivance make the sound of a momentary snap, and those of its echoes, arrive at the ear in the same moment, because they come from different distances. But if the original noise be a continued sound, a man’s voice, for example, uttering a continued uniform tone, the first echo may reach the ear at the same moment with the second vibration of the larynx, the second echo along with the third vibration, and so on. It is evident, that this will produce the same effect. the only difference will be, that the articulations of the voice will be made indistinct, if the echoes come from very different distances. Thus, if a man pronounce the sylla­ble *taw,* and ten successive echoes are made from places which are ten feet farther off, the tenth part of a second (nearly) will intervene between hearing the first and the last. This will give it the sound of the syllable *thaw,* or perhaps *raw,* because *r* is the repetition of *t.* Something like this occurs when, standing at one end of a long line

of soldiers, we hear the muskets of the whole line discharg­ed in one instant. It seems to us the sound of a running

the aim therefore in the construction of a speaking trumpet may be, to cause as many echoes as possible to reach a distant ear without any perceptible interval of time. This will give distinctness, and something equiva­lent to loudness. Pure loudness arises from the violence of the single aerial undulation. To increase this may be the aim in the construction of a trumpet ; but we are not sufficiently acquainted with the mechanism of these undula­tions to bring this about with certainty and precision ; whereas we can procure this accumulation of echoes with­out much trouble, since we know that echoes are, in fact, reflected like light. We can form a trumpet so that many of these lines of reflected sound shall pass through the place of the hearer. We arc indebted to Mr Lambert of Berlin for this simple and popular view of the subject; and shall here give an abstract of his most ingenious Disserta­tion on Acoustic Instruments, published in the Berlin Me­moirs for 1763.

Sound naturally spreads in all directions ; but we know that echoes or reflected sounds proceed almost strictly in certain limited directions. If therefore we contrive a trumpet in such a way that the lines of echo shall be confined with­in a certain space, it is reasonable to suppose that the sound will become more audible in proportion as this diffusion is prevented. Therefore, if we can oblige a sound which, in the open air, would have diffused itself over a hemisphere, to keep within a cone of 120°, we should expect it to be twice as audible within this cone. This will be accomplished by making the reflections such that the lines of reflected sound shall be confined within this cone. We here sup­pose that nothing is lost in the reflection. Let us examine the effect of a cylindrical trumpet.

Let the trumpet be a cylinder ABED (fig. 1), and let C be a sounding point in the axis. It is evident that all the sound in the cone BCE will go forward without any reflection. Let CM be any other line of sound, which we may, for brevity’s sake, call a *sonorous* or *phonic line.* Being reflected in the points M, N, O, P, it is evident that it will at last escape from the trumpet in a direction PQ, equally diverging from the axis with the line CM. The same must be true of every other sonorous line. There­fore the echoes w ill all diverge from the mouth of the trum­pet, in the same manner as they would have proceeded from C without any trumpet. Even supposing, therefore, that the echoes are as strong as the original sound, no advan­tage is gained by such a trumpet, but that of bringing the sound forward from C to *c*. This is quite trifling when the hearer is at a distance. Yet we find that sounds may be heard at a very great distance, at the end of long, narrow, cylindrical, or prismatical galleries. It is known that a voice may be distinctly heard at the distance of several hundred feet in the Roman aqueducts, whose sides are perfectly straight and smooth, being plastered with stucco. The smooth surface of the still water greatly contributes to this effect. Cylindrical or prismatical trumpets must therefore be rejected.

Let the trumpet be a cone BCA (fig. 2), of which CN is the axis, DK a line perpendicular to the axis, and DFHI