time in which the waves run over their own breadth. This is a pretty experiment; and the ingenious mechanician may make others of the ſame kind which will greatly illuſtrate ſeveral difficult points in the ſcience of sounds. We may conclude, in general, that the reflection of sounds, in a trumpet of the uſual ſhapes, is accompanied by a real increaſe of the aerial agitations ; and in ſome particular cases we find the sounds prodigiouſly increaſed. Thus, when we blow through a muſical trumpet, and allow the air to take that uniform undulation which can be beſt main­tained in it, namely, that which produces its muſical tone, where the whole tube contains but one or two undulations, the agitation of a particle muſt then be very great ; and it muſt deſcribe a very conſiderable line in its oſcillations. When we suit our blaſt in ſuch a manner as to continue this note, that is, this undulation, we are certain that the ſubſequent agitations conſpire with the preceding agitation, and augment it. And accordingly we find that the sound is increaſed to a prodigious degree. A cor de chaſſe, or a bugle horn, when properly winded, will almoſt deafen the car ; and yet the exertion is a mere nothing in comparison with what we make when bellowing with all our force, but with not the tenth part of the noiſe. We alſo know, that if we ſpeak through a ſpeaking trumpet in the key which correſponds with its dimenſions, it is much more audible than when we ſpeak in a different pitch. Theſe obſervations ſhow, that the loudneſs of a ſpeaking trumpet arises from ſomething more than the ſole reflection of echoes conſidered by Mr Lambert—the very echoes are rendered louder.

In the next place, the sounds are increaſed by the vibrations of the trumpet itſelf. The elaſtic matter of the trumpet is thrown into tremors by the undulations which proceed from the mouth-piece. Theſe tremors produce pulſes in the con­tiguous air, both in the inside of the trumpet and on that which ſurrounds it. Theſe undulations within the trumpet produce original sounds, which are added to the reflected sounds : for the tremor continues for ſome little time, per­haps the time of three or four or more pulſes. This muſt increaſe the loudneſs of the ſubſequent pulſes. We cannot say to what degree, becauſe we do not know the force of the tremor which the part of the trumpet acquires : but we know that theſe sounds will not be magnified by the trumpet to the ſame degree as if they had come from the mouth-piece ; for they are reflected as if they had come from the ſurface of a ſphere which passes through the agi­tated point of the trumpet. In ſhort, they are magnified only by that part of the trumpet which lies without them. The whole sounds of this kind, therefore, proceed as if they came from a number of concentric ſpherical ſurfaces, or from a ſolid ſphere, whoſe diameter is twice the length of the trumpet cone.

All theſe agitations arising from the tremors of the trum­pet tend greatly to hurt the diſtinctneſs of articulation ; becauſe, coming from different points of a large ſphere, they arrive at the ear in a ſenſible ſucceſſion ; and thus change a momentary articulation to a lengthened sound, and give the appearance of a number of voices uttering the ſame words in succeſſion. It is in this way that, when we clap our hands together near a long rail, we get an echo from each poſt, which produces a chirping sound of ſome continuance. For theſe reaſons it is found advantageous to check all tre­mors of the trumpet by wrapping it up in woollen lifts. This is alſo necessary in the muſical trumpet.

With reſpect to the undulations produced by the tre­mors of the trumpet in the air contiguous to its outſide, they alſo hurt the articulation. At any rate, this is ſo much of the ſonorous momentum uſeleſsly employed ; be­cauſe they are diffuſed like common sounds, and receive no augrhentation from the trumpet.

It is evident, that this inſtrument may be uſed (and ac­cordingly was ſo) for aiding the hearing ; for the ſonorous lines are reflected in either direction. We know that all tapering cavities greatly increaſe external noiſes ; and we obſerve the brutes prick up their ears when they want to hear uncertain or faint sounds. They turn them in ſuch directions as are beſt ſuited for the reflection of the sound from the quarter whence the animal imagines that it comes.

Let us apply Mr Lambert’s principle to this very intereſting caſe, and examine whether it be poſſible to assiſt dull hearing in like manner as the optician has aſſiſted im­perfect sight.

The ſubject is greatly simplified by the circumſtances of the caſe ; for the sounds to which we liſten generally come in nearly one direction, and all that we have to do is to produce a conſtipation of them. And we may conclude, that the audibility will be proportional to this conſtipation.

Therefore let ACB, fig. 6. be the cone, and CD its axis. The sound may be conceived as coming in the direction RA, parallel to the axis, and to be reflected in the points A, b, *c, d, e,* till the angle of incidence increaſes to 90⁰ ; after which the ſubſequent reflections send the sound out again. We muſt therefore cut off a part oſ the cone ; and, becauſe the lines increaſe their angle of incidence at each reflection, it will be proper to make the angle of the cone an aliquot part of 90⁰, that the leaſt incidence may amount preciſely to that quantity. What part of the cone ſhould be cut off may be determined by the former principles.

Call the angle ACD, *a.* We have C*e = (CA* × sin. a)/[(sin. (2n +1)a], when the sound gets the laſt uſeful reflection. Then we have the diameter of the mouth AB = 2CA × sin. *a,* and that of the other end *ef =* C*e* × *2(*sin. *a).* Therefore the sounds will be conſtipated in the ratio of CA2 to Ce2, and the trumpet will bring the ſpeaker nearer in the ratio of CA to Ce.

When the lines of reflected sound are thus brought to­gether, they may be received into a ſmall pipe perfectly cylindrical, which may be inſerted into the external ear. This will not change their angles of inclination to the axis nor their denſity. It may be convenient to make the in­ternal diameter of this pipe 1/3 of an inch. Therefore C*e* × sin. *a* is = 1/6 of an inch. This circumſtance, in conjunction with: the magnifying power propoſed, determines the other di­menſions of the hearing trumpet. For *Ce = I/(6 sin. a) = (CA* × sin. a)/[sin. (2n + I)a], and CA = [sin. (2n + I)a]/(6 sin.2 a).

Thus the relation of the angle of the cone and the length) of the inſtrument is aſcertained, and the sound is brought nearer in the ratio of CA to C*e,* or of sin. (2n + I)a to sin. *a.* And ſeeing that we found it proper to make (2n + I)a = 90⁰, we obtain this very simple analogy, 1 : sin. *a =* CA ; G. And the sine of 1/2 the angle of the cone is to radius as I to the approximating power of the inſtrument.

Thus let it be required that the sound may be as audible as if the voice were 12 times nearer. This gives CA/Ce = 12.

This gives ſin. a = I/12, and a = 4⁰ 47', and the angle of the cone = 9.34. Then CA = I/(6 sin.2 a) = I/(6 1/444) = 144/6, = 24. Therefore the length of the cone is 24 inches. From