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 requires ; 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 bands together near a long rail, we raise 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 lists. 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 aug­mentation from the trumpet.

It is evident that this instrument may be used 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 ABC, 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 90° ; after which the subsequent reflections send the sound out again. We must therefore cut off a part of 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 90°, 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.(2*n* + 1)*a*, when the sound gets the last useful reflection. Then we have the diameter of the mouth AB = 2 CA ∙ sin. *α,* and that of the other end *ef = Ce ∙* 2 sin. *a.* Therefore the sounds w ill 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 1/3d of an inch. Therefore Ce ∙ sin. *a* is = 1/6th of an inch. This circumstance, in con­junction with the magnifying power proposed, determines the other dimensions of the hearing trumpet. \*\*\*For Ce = ,rJ—

, b sin. α

CA sin. a , \_ , sin. *(2n* J- 1 *a)* = -—τπ rv > ≡ CA = —-J—√- -.

sin. *(in* -f- 1 *)a* b sin? *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 Ce, or of sin. (2n -∣- 1) *a* to sin. e. And seeing that we found it proper to make (2n -J- 1) *a —* 90°, we obtain this very simple analogy, 1 : sin. *a —* CA : Ce. And the sine of 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 CA

as if the voice were 12 times nearer. This gives — = 12;

and sin. o = γ^, and *a* — 4o 47,, and the angle of the cone = 9° 34,. Then CA = —!— = —— = —

6 sin.\*« 6χ-j-[r 6

≡ 24. Therefore the length of the cone is 24 inches.

CA

From this take *Ce* as — = 2, and the length of the trum­pet is 22 inches. The diameter at the mouth is 2 *Ce =* 4 inches. With this instrument one voice should be as loud as 144.

If it were required to approximate the sound only four times, making it 16 times stronger than the natural voice at the same distance, the angle ACB must be 29°, A*e* must be 2 inches, AB must be 11/3d inch, and *ef* must be 1/3d of an inch.

It is easy to see that when the size of the ear-end is the same in all, the diameters at the outer end are proportional to the approximating powers, and the lengths of the cones are proportional to the magnifying powers.

We shall find the parabolic conoid the preferable shape for an acoustic trumpet ; because, as the sounds come into the instrument in a direction parallel to the axis, they are reflected so as to pass through the focus. The parabolic conoid must therefore be cut off through the focus, that the sounds may not go out again by the subsequent reflections; and they must be received into a cylindrical pipe of one third of an inch in diameter. Therefore the parameter of this parabola is one sixth of an inch, and the focus is one twelfth of an inch from the vertex. This determines the whole instrument ; for they are all portions of one para­bolic conoid. Suppose that the instrument is required to approximate the sound 12 times, as in the example of the conical instrument. The ordinate at the mouth must be 12 times the 6th of an inch, or 2 inches ; and the mouth diameter is four inches, as in the conical instrument. Then,