THE EDELMANN "GALTON-PFEIFE."

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When in Munich, in the month of October last, I attended Professor Bezold's clinic, and had the advantage of seeing him test a number of patients with Professor Dr. von Edelmann's most recent "Galton-Pfeife." No one who has been at that clinic can have failed to have been struck with the pains Professor Bezold takes in the exhaustive examination of his cases, and in nothing more so than in the accurate determination of the hearing of every patient attending at it. This was specially seen in the application of the Galton pipe, to accurately determine the exact tone and number of vibrations per second (in the higher tones) heard, the results being recorded, with the particulars of the case, at each visit. Having now used this Galton pipe myself since my return, it occurred to me that it might be of interest to other otological workers, who have not seen it, to know its construction and use.

The value of the Galton whistle in estimating the perceptive power of the ear for high tones, is well known to every otologist, and it is more especially useful when used side by side with the tuning-fork for the differentiation of simple middle-ear deafness and that arising from some affection of the labyrinth or auditory nerve. To obtain a whistle which would give us certain records of the varying hearing for these higher tones was a matter of the greatest importance for the otologist engaged in estimating the improvement in hearing made by the patient. This could only be done by an accurate and carefully taken record of the hearing power when the patient first came, and retesting from time to time at subsequent visits. It may interest those who have not already used the instrument, to have a short description of Professor Edelmann's most recently constructed Galton pipe, by means of which, and by the aid of Kundt's dust figures, the relative number of vibrations in such high tones is accurately determined, as well as the number of vibrations per second in each.

Up to quite recently the testing of the tones of the Galton whistle was confined to experiments made with each instrument, tried by the hearing of an ear in which the sense was supposed to be perfect. The length of the pipe was reduced to the smallest point of audible vibrations, its mouth also being made as small as practicable. This gave the limit of hearing of the ear at the time it was tested. Below this nothing was heard save the passing of the air through the pipe, the surmise as to the highest tones that
the particular whistle was capable of producing being arrived at by a calculation derived from a knowledge of the lowest tone that particular whistle could produce, the length and calibre of the pipe being known. The influence of the distance of the mouthpiece from the pipe in producing the tone was not taken into consideration, and hence the conclusions arrived at as to the higher tones were only approximately correct. It has been clearly proved by Kundt's dust figures that the production of these upper tones varies according to the position of the mouthpiece from the pipe. Thus in the new Galton pipe of Edelmann regular vibrations are only produced when the mouthpiece is distant from the pipe between 1·8 and 3·8 mm.; any further widening of the space preventing the production of clear tone. It records a tone of 54,900 complete vibrations at a length of pipe of 0·2 mm. and 0·6 width of mouth. Pure tones can only be measured if the length of the pipe is not reduced below 8 mm. Melde holds that the perception of high notes depends to an extent upon the strength of the tone, and those of

the new pipe are very strong. With it we can prove absolutely that some persons can hear tones of 50,000 or even more vibra-

1 By taking the exact length of a wave with a compass and millimetre measure, and dividing the velocity of sound (at mean temperature) by this, we arrive at the number of vibrations in a given tone—

\[ n = \frac{v}{\lambda} \]
When we formerly supposed," says Edelmann, "that we had reached the highest audible tones, we were most likely mistaken, as in all probability the pipe did not sound."

It will be seen from Fig. 1 that the "Galton-Pfeife" consists mainly of two parts, with an intermediate strong handle

Galton-Pfeife No. 446. 1

| Teilbezeichnung | Pfeifentage | Maßwerte | Schwingungszahl pro Sekunde | Pfeifentage | Maßwerte | Schwingungszahl pro Sekunde | Pfeifentage | Maßwerte |
|----------------|------------|----------|----------------------------|------------|----------|----------------------------|------------|----------|
| a              | 1 1/4      | 3900     | 10000                      | c          | 3800    | 10000                      | d          | 2135    | 10000      |
| b              |            | 4145     | 12000                      | e          | 2135    | 10000                      | f          | 5220    | 10000      |
| c              | 3800       | 11000    | 12000                      | g          | 4500    | 10000                      | h          | 6000    | 10000      |
| d              | 2135       | 12000    | 10000                      | i          | 5220    | 10000                      | j          | 3900    | 10000      |
| e              | 3800       | 12000    | 10000                      | k          | 5220    | 10000                      | l          | 2135    | 10000      |
| f              | 5220       | 10000    | 12000                      | m          | 3900    | 11000                      | n          | 5220    | 10000      |
| g              | 2135       | 10000    | 12000                      | o          | 3900    | 10000                      |
| h              | 12000      | 10000    | 12000                      | p          | 5220    | 10000                      |
| i              | 12000      | 10000    | 12000                      | q          | 3900    | 10000                      |
| j              | 12000      | 10000    | 12000                      | r          | 3900    | 10000                      |
| k              | 12000      | 10000    | 12000                      | s          | 3900    | 10000                      |
| l              | 12000      | 10000    | 12000                      | t          | 3900    | 10000                      |
| m              | 12000      | 10000    | 12000                      | u          | 3900    | 10000                      |
| n              | 12000      | 10000    | 12000                      | v          | 3900    | 10000                      |
| o              | 12000      | 10000    | 12000                      | w          | 3900    | 10000                      |
| p              | 12000      | 10000    | 12000                      | x          | 3900    | 10000                      |
| q              | 12000      | 10000    | 12000                      | y          | 3900    | 10000                      |
| r              | 12000      | 10000    | 12000                      | z          | 3900    | 10000                      |

Fig. 2.—Table accompanying No. 446 Galton pipe, giving the tones, the lengths of pipe, widths of mouthpiece, and vibrations per second for each tone. Also the length of pipe and width of mouthpiece required to produce a given number of vibrations per second, from 10,000 to 50,000.

(F) to hold the whistle steadily by. The upper portion is the pipe (D), which is fitted accurately with a piston. This can be readily moved up or down in the pipe by the lid (C), which stops its cylindrical opening (E). The distance of the piston from

1 Ztschr. f. Ohrenh., Wiesbaden, Bd. xxxvi.
the lower end of the pipe is marked by a scale (J), most perfectly adjusted, in millimetres, from 0 to 25. The lower part is the mouthpiece, which has an aperture in the form of a ring (G) through which the air passes, and this being brought directly opposite the aperture in the lower end of the pipe, the column of air between the two vibrates. An indiarubber ball is attached to the tube of the mouthpiece, and this being held in the hollow of the hand, by compression of the ball with the tip of the thumb, air is propelled through the pipe, when the tones, varying in height according to the distance of the mouthpiece from the pipe and the position of the piston on the latter, are produced. The drum (B) attached to the mouthpiece has its circumference divided into ten equal parts. By rotation of the drum the length of the mouthpiece is altered, and thus its distance from the body of the pipe can be varied, and the "mouth-width" can be defined in tenths by a turning of the screw. We thus see that we can immediately vary and accurately measure in millimetres the length of the column of air in the pipe, and at the same time regulate the exact distance of the mouthpiece from it. Necessarily, the lower the piston in the pipe and the nearer the mouthpiece, the higher the note and the greater the number of vibrations.

Schwendt has made use of Kundt's dust figures to estimate the number of vibrations for each high tone as it is produced by the Galton pipe. These dust figures are produced in the following manner:—A perfectly clean and dry glass tube is closed at one end with a cork, and some dry lycopodium is poured into the pipe, while it is held vertically, and it thus collects at the bottom or closed end of the tube. By now holding the tube in a slightly slanting direction, with the open end downwards, and by tapping it first at right angles, and finally in the direction of the axis of the tube, with a slender stick of wood, such as a pencil, the powder is readily distributed in a long and narrow layer along the tube (Fig. 1, Plate V.). This requires a little practice. The tube is now placed in a horizontal position, and turned slightly, so that the stream of powder lies a little on one side. The mouth of the pipe is now held exactly opposite the aperture of the tube, and when the pipe is sounded the column of air in the tube vibrates. Where the vibrations of
accordance should be first cleaned with nitric acid and useful for this purpose.

usual or had representing (twenty-eight and 0-89 of

podium stream is then distributed, and the lower end of the wax

is fixed to a piece of wood or the side of a table. The tone is then
taken (Fig. 5, Plate V.). Each time the experiment is repeated, it
is better to remove the tube from the table, for redistribution of
the powder. Following these simple directions of Schwendt, I have
had no trouble in obtaining, in tubes of various sizes, the charac-
teristic dust waves. I have photographed some of these for the
purposes of this paper. Fig. 2, Plate V., shows a wave taken with
the pipe 22-4 mm. in length, and the mouth width 2-2 mm.,
representing the tone A⁴, 3480:00 vibrations per second. The
wave measures nearly 100 mm. Fig. 3, Plate V., shows five
waves (ten ventral segments), 11 cms., that is 110 mm., each
wave being 22 mm. in length. These waves were produced by
a length of pipe 10-75 mm. and a mouth width of 0-89 mm.,
producing the tone E², 6960:00 vibrations per second. Fig. 4,
Plate V., shows eight waves (sixteen ventral segments), measuring
12½ cms., that is 122½ mm., each wave being about 15 mm. in
length. These waves were formed by a length of pipe 5-35 mm.
and 0-89 of a mouth-width, representing a tone of G⁶, 12,401
vibrations per second. Fig. 5, Plate V., shows fourteen waves
(twenty-eight ventral segments), measuring 75 mm., each wave
being 5-3 mm. These waves were produced by a length of pipe
1-01 mm. and a mouth-width of 0-89. Fig. 6, Plate V., shows
waves produced by a length of pipe 0-5 mm. and 0-89 of mouth-
width. Ten waves measure over 44 mm., each wave being 4-4 mm.,
representing a tone of D³, or 37,162-24 vibrations per second.²

I take but a few clinical examples for my purpose. A lady
consulted me for deafness of considerable duration, which had
been for some time stationary. Physical signs, and the various
usual tests with watch, by whispering, and tuning-fork, proved the
case to be one originally of middle-ear deafness, associated with

¹ The greatest care must be taken to thoroughly dry the tube, by a sand bath
or otherwise. Both ends should then be corked, and dipped in paraffin. The tube
should be first cleaned with nitric acid and alcohol. Dried mustard seeds are also
useful for this purpose.

² In the table, Fig. 1, Plate V., the correct lengths of these waves are given, in
accordance with the reduction in the actual size of the tubes.
stenosis of the Eustachian tubes. Watch not heard on contact. Tuning-fork C (260 vibrations) and C (512 vibrations) were heard by bone-conduction well, and badly by air-conduction (Rinne), the sound ceasing rapidly. By the "Galton-Pfeife" I found that she heard 7812.32 vibrations per second with the right ear, and 6960.00 with the left. Testing her repeatedly, the same result was arrived at. There was no doubt that here there was also cochlear involvement.

A lady who had suffered in the past from otitis media, resulting at the time in perforation in one ear which had been for some time closed, responded but imperfectly to the tests of acoumeter, watch, and whispering, hearing the tuning-fork about equally to bone- and air-conduction. There was no Eustachian obstruction or collapse in the right ear, but there was stenosis of the left tube. Her principal symptoms were those associated with rigidity of the membrane and ossicular ankylosis, difficulty of hearing in general conversation, and the necessity for fixing her attention in listening. With her right ear she heard 32,870 vibrations well. In the left ear she heard about 30,000. The labyrinth here was obviously intact.

A gentleman who had been deaf for some years, hearing only loud speech, not hearing the watch on contact with either ear, and the acoumeter only by bone-conduction with the right ear, and at 2 in. distance with the left, gave a marked negative response to Rinne's test. There were clear clinical signs of middle-ear affection. He did not hear the C fork (260 vibrations) by air-conduction with either ear, but heard the fork (512 vibrations) held at the same distance with both ears. Tested with the "Galton-Pfeife," he heard 13,640 vibrations per second with the right ear, and with the left somewhat less. There was here some impairment of the labyrinth as well as the middle-ear affection.

In a case of typical old middle-ear deafness in the left ear, the acoumeter heard only by bone-conduction, the watch not heard on contact; with evidence of gross middle-ear changes, and complete Eustachian obstruction, the hearing for high tones was equal to some 35,000 vibrations per second. There was no evidence of any labyrinthine trouble. In the right ear the hearing was normal.

An officer holding an important command in South Africa was struck in his tent by lightning, which rendered him unconscious. Besides other effects at the time, there was a red spot on the mastoid, and the hair over the ear was burnt off. Two fairly large perforations resulted—one in the posterior segment of the membrane, the other below Shrapnell's membrane. Periodical tinnitus followed, and still occurs. Hearing has been fairly restored, as he now hears a whisper in the affected ear, and, as measured by the pipe, some 12,000 vibrations per second. With his good
Fig. 1.—Layer of Lycopodium in tube.
Fig. 2.—Tube (nat. size) dust waves from length of pipe 22·4 mm.; mouth width 2·2; vibration per second 3,480·00; tone $A^4$.
Fig. 3.—Tube (reduced $\frac{1}{2}$) ; $10·75$; $0·89$; $6,960·00$; tone $E^5$.
Fig. 4.—Tube ; $5·35$; $0·89$; $12,401·28$; tone $G^5$.
Fig. 5.—Tube ; $1·01$; $0·89$; $31,249·28$; tone $H^5$.
Fig. 6.—Tube ; $0·5$; $0·89$; $37,162·24$; tone $D^6$.

Approximately the length of the respective waves in these figures is nearly, Fig. 2 = 100 mm.; Fig. 3 = 45 mm.; Fig. 4 = 29 mm.; Fig. 5 = 10·6 mm.; Fig. 6 = 8·8 mm. The slight inaccuracies in the length of the waves in the figures are due to their being produced from photographs. Figs. 5 and 6 are engravings from photographs, as it was found difficult to get the waves directly done from the negatives. Long exposure was necessitated in consequence of the defective light.
ear he hears about 35,000 vibrations per second. The auditory nerve was here probably affected by the injury.  

In a typical case of old apoplectiform labyrinthic seizure, with all the associated symptoms, from which the patient has now in great measure recovered, the hearing in the left ear being normal, the watch being heard on contact only with the right and bone-conduction far exceeding aerial with tuning-forks, the whistle recorded some 36,000 vibrations per second in the normal ear, and some 10,500 in the affected ear.

Having examined the hearing of a number of persons with assumed normal hearing, I have found that a small proportion can reach from 45,000 to 50,000 vibrations per second, and a very large number from 37,000 to over 40,000. I have to thank Professor Edelmann for the use of a second pipe for experimental purposes. Each pipe is numbered as it is issued from the Physico-Mechanical Institute of Professor Edelmann, and accompanying it is a table (Fig. 2) giving all the measurements for length of pipe and mouth-width for the higher tones, and the corresponding number of vibrations per second. A second column gives the length of pipe and the mouth-width for vibrations per second, from 1000 to 5000. The table figured is that of the "Galton-Pfeife" No. 446, the one I have been using.

SOME OBSERVATIONS ON THE PATHOGENY AND TREATMENT OF PES CAVUS, ETC.

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Pes cavus is a condition marked by an increased hollowing of the foot. Many different terms have been applied to it, but that given above is the one used generally. If any change were made it would perhaps be desirable to term it "Talipes Cavus," and so bring its name into closer affinity with the other common deformities of the foot and ankle. Talipes cavus arises from a great variety of causes, the chief of which appear in the following list:—(1) Congenital talipes cavus:—an increased arching of the foot without any other pathological change. (2) As an element in congenital talipes equino-varus. (3) Secondary to talipes equinus or equino-varus, due to infantile paralysis. (4) Secondary to paralytic talipes calcaneus. (5) Secondary to talipes equinus from spastic paralysis, Friedreich's disease and other nerve affections. (6) As

1 Since the above was written, the hearing has much improved, and the tinnitus almost disappeared.

2 The "Galton-Pfeife" can be obtained through the agency of Messrs. Arnold & Sons, West Smithfield.