the destruction of the active centers by the ultra violet light are two independent phenomena the existing theory must be altered. Further experiments are needed to decide this point. The writer's thanks are due to Prof. R. A. Millikan for his kind interest and criticism.

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*ACOUSTIC PRESSURE DISTRIBUTIONS, CHIEFLY IN RESERVOIRS AND IN PIPES**

BY CARL BARUS

BROWN UNIVERSITY

Communicated May 12, 1921

Introductory.—In *Science* (May, 1921) I described an available method of pressure measurement in connection with acoustic phenomena, the method consisting essentially of a shallow mercury U-tube, the head of which is read off by displacement interferometry. Thus the fringe displacement *s* (occurring throughout the following paragraphs) will vary directly as the head in question and therefore with the pressure in the region under investigation. When the shank of the U-tube communicating with the sounding region is quite closed or quite open, significant results are either absent or without interest; but when the sound leak is reduced to the dimensions of a pinhole in foil, or the like small aperture, relatively large pressure increments or decrements are usually found to reside in the vibrating medium, varying with frequency and particularly marked when the region is in resonance with the sound generator. As an instrument for this purpose, a telephone, actuated by a small induction coil and a motor current interruptor is preferable; since non-symmetric inductions conduce to greater sharpness and strength in the phenomena to be observed. The current so obtained may be reversed, changing all the pressure increments into corresponding dilatations. The effect of the symmetrical induction of the magneto does not admit of commutation;

*From a forthcoming Report to the Carnegie Inst., Washington, D. C.

but it is nevertheless definite. When a large resistance, r, put in the telephone circuit produces a fringe deflection, s, the equation sr = constant is near enough for practical purposes and thus the passage from s to p (when called for) is very convenient.

It is the object of the present paper to continue these experiments by treating pressure distributions in vibrating regions of different size and in slender pipes. The case of wide organ pipes I have also investigated, but the results must be given later.

In figure 1, the two shanks of the mercury U-tube at least 6 cm. in diameter (R, air volume 48 cm.^{3}, R', air volume 135 cm.^{3}), are closed on top by glass plates, to receive the rays of the vertical interferometer; i.e., the component rays enter R and R', normally to the diagram.

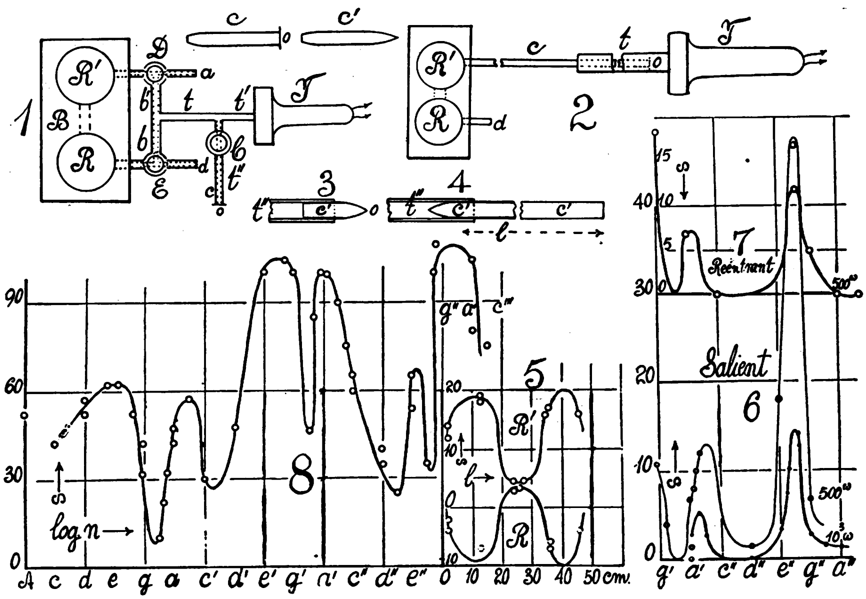
U-tube Used Differentially.—The two different reservoirs R and R' of the U-tube, figure 1, were placed in communication by the branch pipe b, b', containing the three way cocks, D, E, shutting off the air vents a, d, and leading to the telephone T through the quill tubes t and t'. The pinhole is in the second branch t'' at O and a cock, C (here open), is interposed. I had anticipated a differential fringe deflection, owing to the different resonance volumes at R and R'. The result, however, was absolutely negative. Each reservoir (R, R') thus acts like an open air communication with reference to the other, so that the effect of the pinhole valve O vanishes. On using either side separately ($t\ b\ R$ closed, $R'\ D\ a$ open to the atmosphere, or $t\ b'\ R'$ closed, $R\ E\ d$ open) the normal behavior at once appeared.

The only way of securing a differential effect detected, was by elongating either branch (b, for instance, by inserting a long piece, 40 to 80 cm., of rubber tubing). No doubt, this is merely equivalent to stopping, partially, access to either chamber, R or R'.

A variety of correlative experiments were made with the simple (non-differential) apparatus ($t\ b\ R$ closed $R'\ D\ a$ open). I have elsewhere referred to the absence of fringe displacement (nearly) when the copper foil carrying the pinhole is cemented to the mouth of a funnel tube; but the prolongation of the quill tube t'', if the diameter is not increased, is almost indefinitely permissible.

The experiments made suggest a method of obtaining an effect which is at least apparently differential. For this purpose the cock C (fig. 1) is to be closed, so that c is inactive, and the pinhole c (fig. 1) to be inserted either into the branch b' or b. With a normal fringe displacement of 40, the pinhole in b' gave a displacement of 38 fringes; in b correspondingly 27 fringes. Hence the large volume R' is more favorable to a larger displacement than the smaller volume R. It will be observed at once that here these reservoirs act merely like the outside air in the case of the original experiment. Thus there is no true differential effect resulting from the size of resonators, whether the region be closed, open or partially open.

Conical Vents Reversible. Periodicity.—The conical vents c' (fig. 1) may be inserted into the branch tube t'' in two ways, either in the salient position a with the convex surface around the pinhole O outward (fig 3); or in the reentrant position (fig. 4) with the convex surface at O inward. The results obtained are usually reversals of each other, so that a pressure excess is liable to be on the concave side of the conical vent. These results were always consistent in character; but it was soon found that the strength of the telephone current and the length l of the tube $c'c'$ in the reentrant position (fig. 4) greatly modified them. When there is no resistance in circuit, i.e., when the telephone sounds harshly, reversal ceases, so that either the case 3 or 4 produces a pressure within; but even here, on closing the circuit, the fringes in case 4 are seen to move first toward a dilatation and then turn in the direction of pressure.



The position (fig. 3) being the normal case investigated above, the case 4 was studied with 1,000 ohms in circuit, and for different lengths l of the quill tube c', beyond O, from $l = 2$ to over 40 cm. These results are given (fig. 5) the abscissas showing the length l of tube taken and the ordinates the fringe displacements s, both for the region R' alone (positive displacements here denoting dilatation) and for the region R (positive displacements denoting pressure). The results are periodic in marked degree, so that the quill tube (fig. 4) is a musical instrument with a pinhole embouchure; and in fact while the case 3 is nearly silent, 4 audibly reproduces the sound of the telephone. The curve for R' shows two resonance maxima and one minimum, but in all cases the dilatation (positive-displacement s) within R' is sustained, merely changing in degree. The curve for R, however (dilatations for negative s) indicates the occurrence of both dilatations and pressures within this (smaller) region. Both curves are quite consistent (although R' is nearly four times more capacious than R) and one may infer the length of pipe $l = 30$ cm. (fig. 5) or the wave length $2l = 60$ cm. to be an harmonic of the telephone interruptor. This was in fact close to the four foot c.

In a majority of cases the action of the conical vent thus recalls the behavior of the cup anemometer, as the pressure excess is on the concave side; but the lower curve of figure 5 (for R smaller) is out of keeping with this, as between lengths of 20 and 35 cm. of pipe, the pressure excess is within, or on the salient side.

Resonators of Very Large Capacity.—The volume of the region R' (fig. 1) was now further increased by adding an additional cylindrical tube 6.2 cm. in diameter and 10.7 cm. high, closed on top with a glass plate. All parts were (as before) carefully cemented together. The volume added was thus 370 cm.^{3}, as compared with the original 48 cm.^{3}, the ratio of volume increment being 6.7, and the ratio of total to original volume 7.7 The conical vent c', figure 1, here acted much better than the copper foil pinholes c.

Using the motor break and conical valve, the fringe displacements were observed for frequencies between the notes g' and c''' and both with 1,000 ohms and 500 ohms in the telephone circuit. An example of the results is given in the two curves in figure 6, the region R being in communication with the atmosphere and R' closed except as to the salient conical vent specified. The curves are remarkable because of the sharpness of the maxima, which are apparently overtones in the key of B or B flat. It is obvious that the fundamentals of the large closed reservoir R' will lie very low as compared with the frequencies of the diagram and very large fringe displacements may be looked for and were found there. The height of the maxima gradually decreased from g to c''' there.

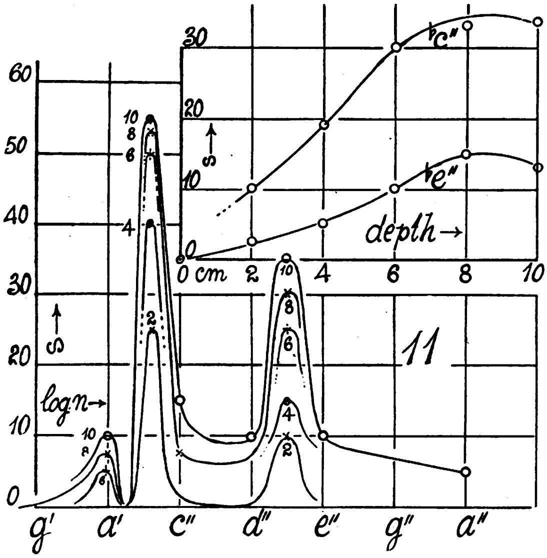
It was now thought desirable to test the conical vent in the reentrant position and data of this kind are given by the curve in figure 7. All the maxima are here dilatations, laid off positively for convenience in comparison with figure 6. The valve action (500 ohms in circuit) is much weaker in figure 7 than in figure 6; but in every other respect figure 6 is symmetrically reproduced. This is a very disconcerting result; for it is not the impulsive displacement of the telephone plate alone which produces the pressure increments within, even if a reversal of the telephonic current (change of poles) changes pressure increments into pressure decrements. The reversal conical pinhole vent in association with a given adjustment of telephone current (poles not changed) will do the same.

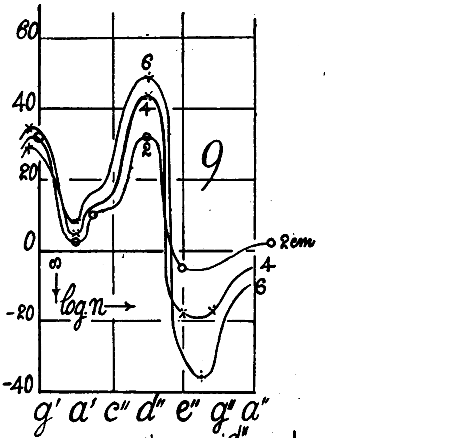
Resonator of Very Small Capacity.—Finally the resonator R' was all but closed (resonator IV), or at least reduced to a shell-like space by a cylindrical inset, closed with a glass plate but a few millimeters above the mercury of the U-tube.

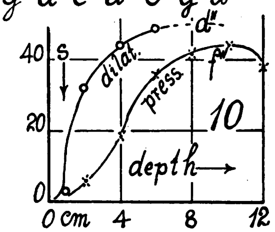
A survey of the fringe displacement corresponding to different harmonics is given in figure 8, 1,000 ohms completing the telephone circuit. Their distribution is less regular than heretofore, and probably the smaller serrations have escaped detection. What particularly astonishes is the occurrence of resonance at the low notes, seeing that the resonator volume is here relatively negligible. The maximum displacement of 100 fringes corresponds to a pressure increment of about .03 cm. of mercury, which though twice as large as obtained with the large resonator III, is nevertheless of the same order of values.

In one respect the present curve (fig. 8) for the shell resonator IV, differs radically from the complete curve for the capacious resonator III. In the latter, conformally with the large volume, the lower notes (8-foot octave) are very much more effective than the notes of the one foot octave. The curve as a whole falls from left to right. In figure 8 the reverse tendency is observed.

The question as to what resonates in case of the small resonator was approached by lengthening the tubing between the telephone and U-tube from its usual length of 48 cm., to 85 cm. and 120 cm. successively. The







shell-like volume of the resonator IV cannot much have exceeded 10 or 15 cm.[3] The tubes added 10, 17, and 24 cm.[3], respectively. To this the shallow volume in the telephone (about 2 cm.[3]) is to be added; nevertheless the greater part of the total volume seems to reside in the tubes.

The results obtained in the frequency survey for maxima and minima showed that the overtones had been differently accentuated. Thus the minimum near d'' passes from positive to negative values as the tube length increases, while the reverse is observed at the maximum near g''. The case for tube additions is then analogous to the occurrence of the vowel sounds, where different overtones are accentuated by variation of the mouth cavity.

The Pinhole Sonde, or Probe.—The possibilities of sounding for pressure by aid of a pinhole valve, O, at the end of a slender tube, c (as in figure 2), communicating with the closed reservoir R' of the U-tube, the other, R, being open to the atmosphere are next to be treated. The telephone T was at first provided with a tubular projection t, 12 cm. deep to the plate and about .75 cm. in inner diameter. This received the probe c (O being at the end of the aluminum tube C 2 mm. in bore, 3 mm. in outer diameter and about 20 cm. long) to different depths, with a view to exploring the pressure within.

The results obtained on inserting the probe to different depths (marked in the graphs, data for 8, 10, 12 cm. of depth showing no further change in the telephone pipe) are given in figure 9, pressures laid off positively downward. The curves are unexpectedly complicated, but consistent, in their character throughout. In place of the simple distribution of pressure in the usual closed organ pipe, there is a maximum pressure increment near f', another at d'' and a very pronounced pressure decrement (negative fringe displacement) near f''.

The increase of pressure from the mouth of t toward the telephone plate 12.5 cm. below, is well shown in figure 10, in which the fringe displacements s for the large dilatation d'' are recorded. The other curve gives the distribution of pressure at f''. These increments rise very rapidly from the mouth inward and at 8 cm. of depth already reach a maximum value. Beyond this, the curves like figure 10 are apt to show a decrease, which is not probably incidental.

The rubber tube was now about halved in length, the present depth to plate being about 5 cm. and the diameter .75 cm. The note obtained with the blower was a faint d' and a strong g''. In the survey in pitch with the pinhole at a depth of 4 cm. there were maxima at d' and particularly at the octave of the blown pipe d'', and minima at c' and a', all well marked. On comparison of the curve for the half pipe with figure 9, for the full pipe, there was actually a complete inversion of results, maxima taking the place of minima. The largest displacement occurred at about 5 mm. from the plate.

Pressures in Smooth Straight Pipes.—These surveys in pitch and depth were completed for a number of telephone blown brass pipes, 1 cm. in diameter and of different lengths; but the very interesting graphs obtained must be omitted here. Thus the pipe 13 cm. long showed enormous maxima at a' and correspondingly large negative minima at d'', at all depths (2, 4, 8, 12 cm.) below the mouth of the tube. Figure 11 reproduces the behavior of the same tube cut down to 10 cm. of length, at different depths 2, 4, 6, 8, 10 cm. below the mouth. Finally similar graphs for a variety of wide tubes and resonators have been worked out and progress made with the installation for symmetrical induction.

THE PREDICTION OF ANNUAL EGG PRODUCTION FROM THE RECORDS OF LIMITED PERIODS

BY J. ARTHUR HARRIS, W. F. KIRKPATRICK AND A. F. BLAKESLEE

STATION FOR EXPERIMENTAL EVOLUTION, CARNEGIE INSTITUTION, AND THE STORRS AGRICULTURAL EXPERIMENTAL STATION

Communicated by C. B. Davenport, March 12, 1921

For the past several years the writers have been considering the possibility of predicting the annual egg production of the domestic fowl from the records of short periods of time. Such records may be determined by trapnesting, or by the use of other criteria when the maternity of the eggs is not required for breeding purposes.[1]

The first definite step in the direction of the use of the egg record of a short period for the prediction of the production during a subsequent or a longer period was, as far as we are aware, taken in 1917 when it was shown[2] that in a heterogeneous series of birds such as are submitted by practical breeders in egg laying contests, the October egg production is correlated with that of every other month of the year. The investigation was carried much further in a second memoir[3] in which the correlations between the records of the individual months and the production of the whole year, between the records of the individual months and those of the remaining 11 months of the year, and between the production of 5 of the individual months and the production of all the other individual months, were published for two series of birds. In this paper the equations for the prediction of total annual production from the record of the individual months were given.

Our purpose here is to state briefly the results of a first test of the possibility of utilizing the linear regression equation (which is strictly valid only for the population from which it is deduced) for the prediction of the records of the birds of a flock the performance of which is unknown as far as the determination of the constants of the equations is concerned.