sphere of secular contraction and the process of isostacy.

(*d*) The effects of secular contraction on the length of the sidereal day.

'The Energy of Condensation of Stellar Bodies': Professor R. S. WOODWARD.

The problem considered in this paper is that of the energy due to the gravitational condensation of gaseous matter from a state of infinite diffusion to a finite spherical mass in which Laplace's law of density holds. The problem is worked out in its generality, formulas specifying the distribution of density, pressure, and potential in the mass being given. Special attention is given to the probable case of the fixed stars of a vanishing surface density.

'The Physical Basis of Long Range Weather Forecasts': Professor CLEVELAND ABBE, U. S. Weather Bureau.

In the absence of the author and of the member who was to present it this paper was read by title. The papers by Professor See and Dr. Moulton were presented by Professor Howe. Those by Professor Dickson, Mr. Keyser, Mr. Parkhurst, Dr. Hutchinson and Professor Macfarlane were read by the secretary. All the other papers were presented by their authors. Several other papers were read before the joint session of Sections A and B. These will be included in the report of Section B.

G. A. MILLER,
Secretary of Section A.

ON THE STABILITY OF VIBRATIONS.

Observations.—The following experiment seems to me to be an interesting illustration of the equation of the damped harmonic oscillation. It also presents a striking illustration of the stability of a given type of vibration.

The necessary apparatus is very simple, consisting of an ordinary open organ pipe (say c'' of the one foot octave) and a cylindrical tin box, 4–5 cms. in diameter and 5–6 cms. long, with a central hole at one end about 1 cm. in diameter. This is adjusted so as to be of the same period as the organ pipe. A König's resonator will do equally well, but if the box has a slightly loose lid, it brings out other phenomena also deserving notice.

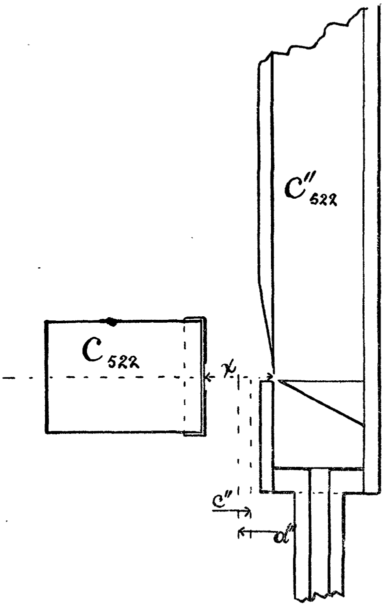
The experiment is as follows: Using a resonator giving b' to e'', depending on the intensity of the blast and with a loose (not sealed) lid, let it be placed symmetrically to the slit of the pipe at a distance, x, from it, as shown in the figure. Then as x decreases from a large distance, to say 3 cms., the resonator trembles violently (felt with the finger), but neither raises nor depresses the note. As x decreases further to 1.7 cms., no marked effect occurs, but pressure in the influx of the organ pipe will force out the octave, which it did not do before. Between $x = 1.7$ and $= 1.5$ there is destructive interference; a mere whiffing is heard from the combined instrument, but an impure octave may be forced out by pressure. Finally, when x decreases further to say 1.1 cms., a clear d'' suddenly breaks forth and is the chief feature of the experiment. For smaller distances (1.1 to .7 cms.) the d'' flattens again to c''.

The same sharpening is produced when the resonator is placed on top of the open organ pipe, mouth inward. If two resonators are used, one as in figure, the other on top, the sharpened note of the one is further sharpened by the other.

When the so-called destructive interference occurs there is no vibration in the resonator; but on pressing the finger against its bottom, the c'' may again be heard.

If the lid of the resonator be cemented on with wax, or if a round König resonator be used, there is no whiffing. The interval, x, of instability is then very small (about .2 cm.) so that the note passes very suddenly from c'' to d''. Too loose a lid merely depresses the tone at short distances.

The rise of the sharpened note will naturally depend on the pitch of the resonator. For a shorter one giving d'' to e'' with increasing blast, the above effect on the organ pipe is an e'' flat. A resonator of pitch d''



to f'' raises the organ pipe to e'' or depresses it to b', as follows: c'' at long ranges, b' at $x = 1.2$, about; b' flat at $x = 1.0$ cm., then suddenly e'' at $x = .9$ cm. Here I thought I had detected two modes of vibration of a system of two degrees of freedom; yet as the butt end of the resonator produced like depressions of tone, this is probably referable to increased friction.

A resonator of pitch a'–c'', definitely below that of the pipe, depressed the tone from c'' to c'' flat. With the butt end the depression was a whole tone. The same resonator on top of the pipe showed just perceptible sharpening. The effect seemed to be the same whether the pitch of the resonator was depressed by lengthening or by reducing the size of the mouth.

Remarks in Explanation.—As the note of the organ pipe is always depressed when the butt end of the resonator or any other obstacle is brought up to the lip, I think that a rough explanation in terms of a system of one degree of freedom will be admissible. Thus the organ pipe is vibrating throughout under more or less resistance. Its period may therefore be given by $T = 2\pi m/\sqrt{ma - b^2}$, where m is the inertia of the vibrating body, a is Hooke's constant and $2b$ the coefficient of friction. From another point of view, $T = 2\lambda m/b$, if $\lambda = Tb/2m$ is the logarithmic decrement.

If the friction is increased by presenting an obstacle at the lip, b is increased and therefore T is increased or the tone is depressed. If, however, the friction is decreased by presenting a negative obstacle—*i. e.*, the mouth of a resonator—near the lip, which initially tugs and pushes synchronously with the vibration of the lamina of air from the lip, then b is decreased and T is decreased. In other words, the tone is sharpened. It is in this way that I have presented this very striking phenomenon as an illustration of the given equation, though the full explanation cannot of course stop with a single degree of freedom.

As to the reasons for the absorption of the organ pipe note in the resonator, if its lid is somewhat loose, it is clear that this cannot be a case of ordinary interference; for in such a case there should be vibration in the resonator, whereas none is manifest to the touch at least. In other words, each successive vibration of the organ pipe is quenched in the resonator, being completely damped out. Hence the effective friction in the resonator considered alone for the given conditions is so large as to change the harmonic type of decay in the exponential type, the period becoming imaginary. Now it is interesting to note that this takes place at a particular distance, x, from the lip within narrow limits, the resonator responding strongly to c'' for larger values of x, and to d'' for smaller values. The whiffing suggests the impure octave b'', while increased pressure at the organ pipe brings out the strong octave c'''.

Stability of vibration. Vibrational hysteresis.—Finally, the peculiar phenomenon observed in connection with the stability of vibration deserves special mention. A König resonator mounted on a graduated slide, x, is convenient for the purpose. If the mouth of this apparatus is approached slowly from a large distance, x, to within 2.2 cm. of the lip, c'' is strongly resounded. On passing these limits, d'' breaks forth almost suddenly. With this d'' sounding from the combined system, withdraw the resonator slowly again; d'' will be retained until x has increased to 2.8 cm., about. Hence, within 6 mm. of approach, the note is either c'' or d'', depending upon whether the position has been reached from large or from small values of x, within the limits given. See figure. With a carefully regulated slow influx, 9 or even 10 mm. of range were attained with a sharp clicklike breakdown at each end. The change from c'' to d'' is usually more sudden, that from d'' to c'' more gradual, perhaps, but the *hysteresis-like* character of the phenomenon is unmistakable. As I have recently been studying hysteresis* from different points of view (cf. forthcoming paper in the *Physical Review*, on temporary set), the present purely vibrational case of it is to me strikingly interesting.

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* *American Journal of Science*, XI., 1901, p. 97.

THE FIFTH INTERNATIONAL ZOOLOGICAL CONGRESS.

THE Fifth International Zoological Congress held its sessions in Berlin from August 12 to August 16, under the gracious protection of His Highness the Crown Prince of Germany and the presidency of Professor K. Möbius, and, so far as concerns the attendance, was the most successful of all that have so far been held. Most of the countries of Europe were well represented, delegates were present from Canada, Brazil, Mexico and the United States, the total number of those present being considerably over six hundred. The members in attendance from the United States were: Professors E. B. Wilson, of Columbia University, and Patten, of Dartmouth College; Dr. Stejneger, of the Smithsonian Institution; Dr. C. W. Stiles, of the National Museum; Mr. W. A. Murrell, of Cornell University; Mr. J. Hunter, of St. Louis, and Professor J. Playfair McMurrich, of the University of Michigan. Owing to the large number of papers to be presented, seven sections were established, namely, general zoology, experimental zoology, vertebrata (biology and systematic), vertebrates (anatomy and embryology), evertebrata (exclusive of arthropoda), arthropoda and nomenclature; and while such a separation of subjects was undoubtedly necessary and the grouping as satisfactory as might be, it made it impossible to attend the reading of many of the papers in which one might be interested.

The papers read were very varied in character, some being on special subjects, some, indeed, altogether too special for such a meeting, and others on the more general problems of zoology. If a single subject is to be selected as that which awakened the greatest interest, the new or rather the rekindled struggle between vitalism and mechanism must be the one chosen. Driesch, who has precipitated the renewal of the struggle, presented his views to a well-attended meeting of the section of experimental zoology, upholding, in a forcible and clearly stated argument, the vitalistic side of the question, while, in the discussion which followed, Ziegler, Roux and Rhumbler took the opposite side, maintaining that it is too early yet to admit the existence of vitalism or to postulate an active purpose-