the same number of days in March, there was a reduction representing the saving of 290 lives, and this not taking into account an increase in the population of more than 3,000 souls.

In March the largest number of persons succumbed to disease on the 31st, there being on that day 137 deaths recorded; on the 30th of April the maximum limit was reached, amounting to but 124 deaths.

The deaths of children under five years of age during March were 1,221, and in April but 1,075; and yet diarrhoeal diseases carried off in April 56 persons, and only 32 in the preceding month. Scarlet-fever caused a mortality of 49 this month, as compared with 42 in March. The lines in the chart representing scarlet-fever and the diarrhoeal diseases, which for two months have nearly coincided, now begin to diverge, and the separation will be more and more marked as the season advances. The increase of deaths from diarrhoeal diseases appears to be pretty evenly distributed throughout the month, and not very perceptibly increased in any one period over another. The largest number of deaths from diseases of this nature in any one day was 5, on the 22d. The week in which this occurred was characterized by high temperatures, 81°, 74°, 74°, 81°, 84°, and 83° being the maxima for six consecutive days beginning with the 19th; and during this period there were 16 deaths from this class. The next largest number of deaths was 4, on the 11th inst.; and on six consecutive days of that week the maxima reached by the thermometer were respectively 70°, 52°, 64°, 68°, 69°, and 67°, and the recorded deaths were 14.

This is an interesting comparison, and would seem to show that there are other influences at work in the causation of diarrhoeal diseases than an elevation of temperature at one part of the day. On these days, when the thermometer was ranging from 74° to 84° in the afternoon, it was at other parts of the day much lower, sometimes as low as 48°. It is the high temperature continued throughout the greater part of the twenty-four hours, and repeated day after day, as occurs in July and August, which produces such fearful ravages among the inhabitants of the large cities. Especially is this destructive influence marked when the air is laden with moisture. A study of the accompanying chart will show, that, at the time when these high temperatures occurred, the air was comparatively dry; on the 23d inst., when the maximum temperature was 84°, the humidity was but 60, saturation being 100. That this is an important element in the problem is not to be overlooked. It is a matter of common experience that a temperature of 90° with a dry atmosphere can be more comfortably borne than one of 80° with the air saturated with moisture. In the one case evaporation from the body is rapid, resulting in a cooling of the surface; in the other it is impeded, or seriously interfered with.

Consumption and diphtheria show for April, as compared with March, a slight decrease in mortality.

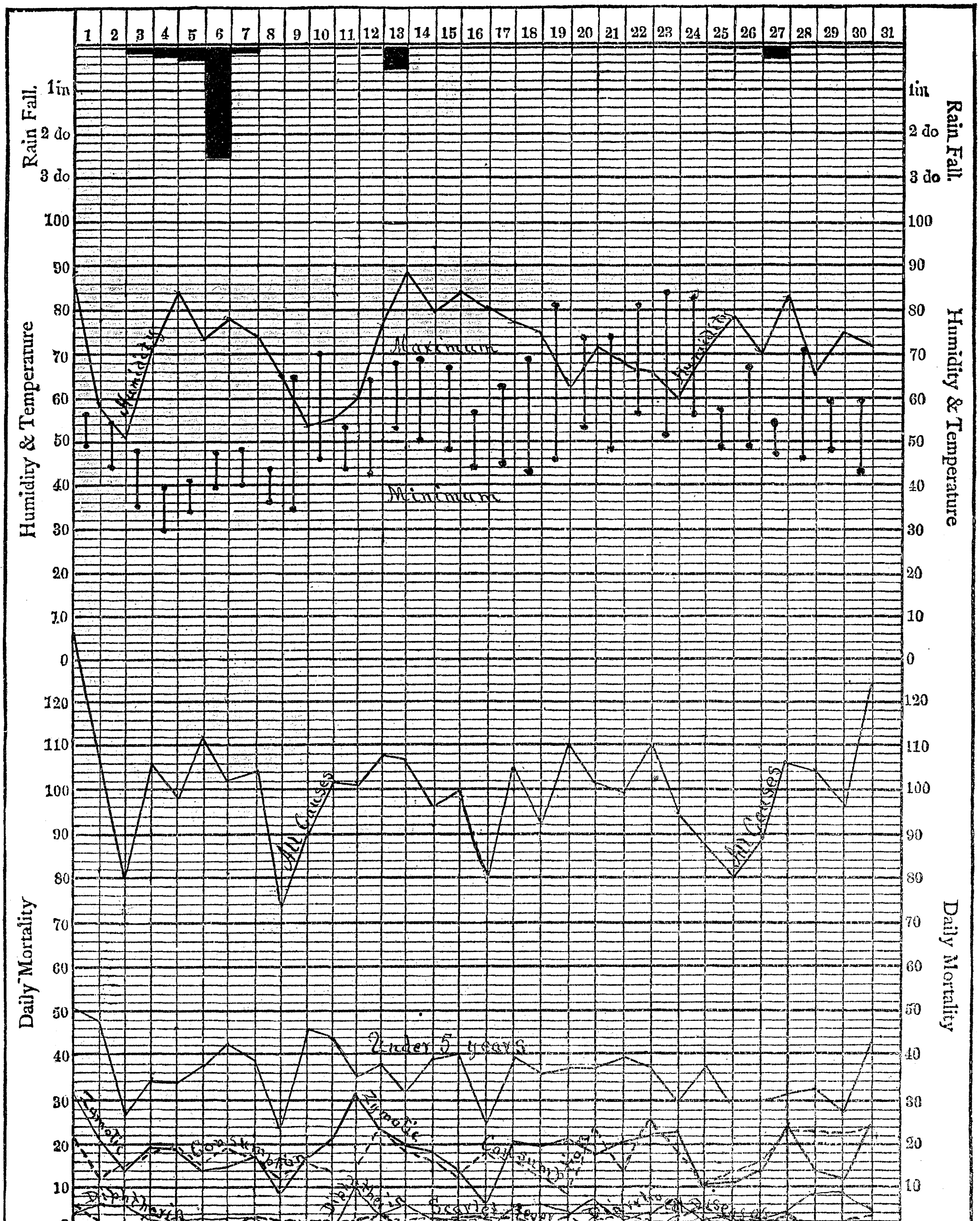
The mean temperature for the month was 52.87°, that for March having been 37.60°. The maximum was on the twenty-third day, the thermometer then registering 84°. This is the highest recorded in the month of April since 1871. 62° was the highest point reached by the mercury during March: its lowest point in that month was 8°, while during April at no time was it more than two degrees below freezing.

While the number of days upon which rain fell was but seven, rather less than the average for a considerable number of years, yet the total amount of water which fell was 3.85 inches, considerably above the average amount for the same period. On the 4th of the month one-quarter of an inch of snow fell, and three-quarters of an inch on the day following. In the corresponding month of 1885, there were several flurries of snow, the amount being too small to accurately measure. Snow is not a frequent visitor in the month of April: in the year 1870 it fell to the depth of two inches and a half; in 1875 no less than thirteen inches and a half are recorded; and in the years 1882 and 1883 there was in each one half-inch. With these exceptions, no snow has fallen in April during the past fifteen years. From a meteorological point of view, April, 1886, was an exceptional month.

SYMPATHETIC VIBRATIONS OF JETS.[1]

AFTER a brief historical notice of the observations of Savart, Masson, Sondhauss, Kundt, Laconte, Barret and Tyndall, Decharme, and Neyreneuf, on the sympathetic vibrations of jets and flames. the author described his own experiments. Attention was directed to the subject by the accidental observation that a pulsating air-jet directed against a flame caused the latter to emit a musical sound. The pitch of this sound depended solely on the rapidity of the jet-pulsations, but its intensity was found to increase in a remarkable way with the distance of the flame from the orifice. In order to study the phenomenon, air was allowed to escape against the flame from a small orifice in the diaphragm of an ordinary telephone, the chamber behind the diaphragm

[1] Abstract of paper read before the Royal society, April 28, by Chichester A. Bell.



Weekly Mortality	726	683	697	694	
Weekly mean Thermometer	45.7°F	44.0 F	52.9 F	64.0 F	
Weekly mean Barometer	29.977	29.919	30.304	30.023	

being placed in communication with a reservoir of air under gentle pressure (fig. 1). Vibratory motions being then excited in the diaphragm, by means of a battery and a microphone or rheotome in a distant apartment, the discovery was made that speech as well as musical and other sounds could be quite loudly reproduced from the flame. Certain observations led the author to suspect that motion of the orifice, rather than compression of the air in the chamber, was the chief agent in the phenomenon; and, in fact, precisely similar results were obtained when a light glass jet-tube was cemented to a soft iron armature, mounted on a spring in front of the telephone magnet (fig. 2).

Experiment also showed that an air-jet at suitable pressure directed against a flame repeats all sounds or words uttered in the neighborhood (fig. 3). Except, however, where the impressed vibrations do not differ widely in pitch from the normal vibrations of the jet (discovered by Sondhauss and Masson), these effects are likely to escape notice owing to the inability of the ear to distinguish between the disturbing sounds and their echo-like reproduction from the flame.

In these experiments the primary action of the impressed vibrations was undoubtedly exerted on the air-jet; but a singular and perplexing fact was that no sound, or at best very faint sounds, could be heard from the latter when the flame was removed, and the ear, or the end of a wide tube connected with the ear, was substituted for it. Suspecting, finally, that the changes in the jet, effective in producing sound from the flame, must be relative changes of different parts of it, the author was led to try a very small hearing-orifice, about as large as the jet-orifice (fig. 4). The results were most striking. By introducing this little hearing-orifice into the path of a vibrating air-jet, the vibrations can be heard over a very wide area. Close to the jet-orifice they are so faint as to be scarcely audible; but they increase in intensity in a remarkable way as the hearing-orifice is moved away along the axis of the jet, and reach their maximum at a certain distance. Experiments with smoked air showed that this point of maximum sound is that at which the jet loses its rod-like character, and expands rapidly: it has been named the 'breaking-point,' because just beyond it the sounds heard from the jet acquire a broken or rattling character, and at a greater distance are completely lost. The distance of the breaking-point from the orifice diminishes as the intensity of the disturbing vibrations is increased, and also depends to some extent on their pitch and on the velocity of the jet. With orifices of from 1 to 1.5 mm. in diameter, it usually varies from 1 to 6 cm. The vibrations of an air-jet may also be heard at points not situated on the axis; but they are always most intense along the axis, and become rapidly fainter as the distance from it increases.

With glass jet and hearing-tubes, and a light gas bag to serve as reservoir, these experiments are easily repeated; but simple apparatus for more careful experiments is described. The author's general conclusions from his experiments and those of others are as follows: —

A jet of air at moderate pressure (below 10 mm. of water) from an orifice from 1 to 1.5 mm. in diameter, forms a continuous column for a certain distance, beyond which it expands and becomes confused.

Any impulse, such as a tap on the jet support, or a short and sharp sound, causes a minute disturbance to start from the orifice. This disturbance increases in area as it progresses, and finally causes the jet to break. By directing the jet against a flame or a hearing-orifice, it is readily perceived that such disturbances travel along the jet-path with a velocity which is not that of sound in air. In fact, the sound heard in the ear-piece resembles an echo of the disturbing sound.

The disturbances produced by sounds of different pitch travel along the jet-path with the same velocity. This is evident, since otherwise accurate reproduction of the complex vibrations of speech at a distance from the orifice would be impossible. This velocity is much less than that of sound in air, and is probably the mean velocity of the stream.

A vibrating air-jet playing into free air gives rise to very feeble sounds, but these sounds are much intensified when the jet impinges on any obstacle which serves to divide it into two parts. Of such arrangements, the best is a perforated surface, the orifice being placed in the axis of the jet.

A jet of air at low pressure responds to and reproduces only sounds of low pitch. Sounds above a certain pitch, which depends on the pressure, either do not affect it or are only faintly reproduced.

At pressures between 10 and 12 mm. of water, an air-jet reproduces all the tones of the speaking voice, and those usually employed in music, with the exception of very shrill or hissing noises. When the pressure in the reservoir equals about 13 mm. of water, hissing sounds are well reproduced, while sounds of low pitch become fainter. At higher pressures, up to about 25 mm. of water, shrill or hissing noises produce very violent disturbance, while ordinary speech tones have little effect. But at these pressures sounds of high pitch frequently cause the jet to emit lower sounds of which they are harmonics.

In general a pressure of about 12 mm. of water will be found most suitable for reproducing speech or music. Under this condition the jet is very sensitive to disturbances of all kinds, and will reproduce speech, music, and the irregular sounds classified as 'noises.'

It must be understood that the pressures here given are only suitable for jets of not too small diameter. When the diameter of the orifice is only a small fraction of a millimetre, the above limits may be much exceeded, since the velocity of efflux no longer depends solely on the pressure.

A jet of air escaping from a perfectly circular orifice does not vibrate spontaneously so as to emit a musical sound; but musical vibrations may be excited in it by the passage of the air on its way to the orifice through a resonant cavity, or through any irregular constriction.

An air-jet impinging on any obstacle, such as a flame, frequently vibrates spontaneously, if the obstacle is at sufficient distance and of such a nature as to diffuse the disturbances produced by impact, or throw them back on the orifice. This constitutes one of the chief objections to the use of a flame as a means of rendering audible the vibrations of a jet. The disturbances excited in the surrounding air by the impact of the stream upon it are so intense as easily to react on the orifice. When, therefore, the jet is thrown into any state of vibration, it tends to continue in the same state, even after the exciting sound has ceased.

A jet of air usually responds most energetically to some particular tone or set of related tones (Sondhauss). Such a particular tone may be called the jet fundamental. The practical inconvenience arising from this may be diminished by raising the air-pressure until the jet fundamental is higher than any of the tones to be reproduced.

When a flame and an air-jet meet at right angles, vibrations impressed upon the flame-orifice also yield sound. The conditions of pressure, etc., are somewhat different; but the changes produced at the orifice grow in the same way as those in an air-jet. The best results are obtained when a gentle current of air is directed from a wide tube just below the apex of the blue zone.

It is difficult, at first sight, to account for the fact that a vibrating jet gives rise to sound only when it strikes upon some object which divides it into two parts. The following experiments, however, in some sense explain this. The relative normal velocity at different points in the stream may be measured by introducing into its path the open end of a capillary tube which is connected with a water manometer. This velocity diminishes continuously along the axis from the orifice to the breaking-point, and also diminishes continuously from any point of the axis outwards towards the circumference. Now, a sudden disturbance communicated to the air at the orifice will be found to produce a fall in velocity along the axis of the jet, but a rise in velocity along its extreme outer portions. It thus appears that the changes along the axis and along the circumference, produced by a disturbance, are of opposite character. When the jet plays into free air, these opposing changes neutralize each other in the main; but this interference is prevented when the jet strikes upon any object which serves to divide it.

When a vibrating air-jet plays against a small flame, the best sounds are heard when the stream strikes the flame just below the apex of the blue zone. At the plane of contact an intensely blue flame ring appears, and this ring vibrates visibly when the jet is disturbed. The production of sound from it doubtless depends on changes in the rate of combustion of the gas. This may be proved by inserting into the ring a fine slip of platinum, connected in circuit with a battery and a telephone (fig. 5). When the jet is thrown into vibration, the consequent variations in the temperature of the platinum affect its conductivity, and hence a feeble reproduction of the jet-vibration may be heard in the telephone.

To Savart we are mainly indebted for our knowledge of the sympathetic vibrations of liquid jets. This physicist showed that a liquid jet always tends to separate into drops at a distance from the orifice in a regular manner; and that this tendency is so well marked, that when the jet strikes upon any object, such as a stretched membrane, so arranged that the disturbances caused by impact may be conducted back to the orifice, a definite musical sound is produced. The pitch of the sound, or the number of drops separated in a given time, varies directly as the square root of the height of liquid in the reservoir, and inversely as the diameter of the orifice. Savart further showed that external vibrations impressed upon the orifice may act like the impact disturbances, and cause the jet to divide into drops. Impact on a stretched membrane may then cause the reproduction as sound of the impressed vibrations. The tones capable of producing this effect were considered to lie within the limits of an octavo below and a fifth above the jet normal.

The author has found, however, that jets of every mobile liquid are capable of responding to

FIG. I.

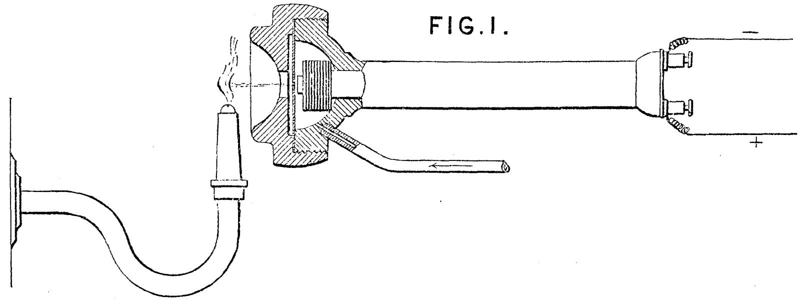


FIG. II.

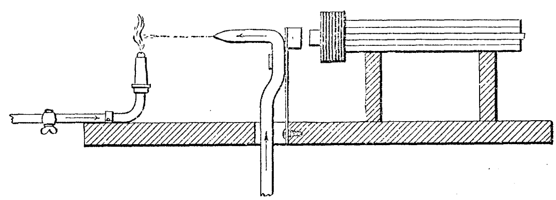


FIG. III.

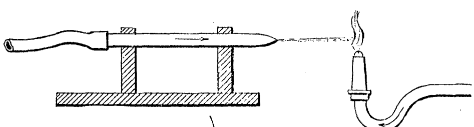
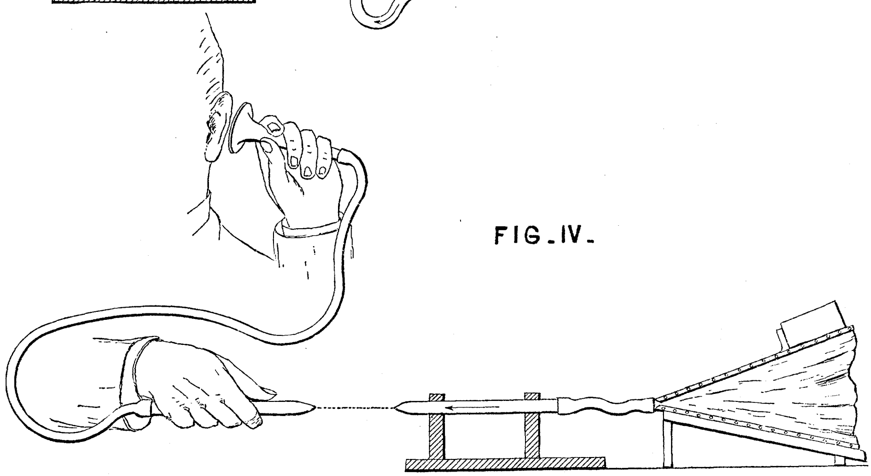


FIG. IV.



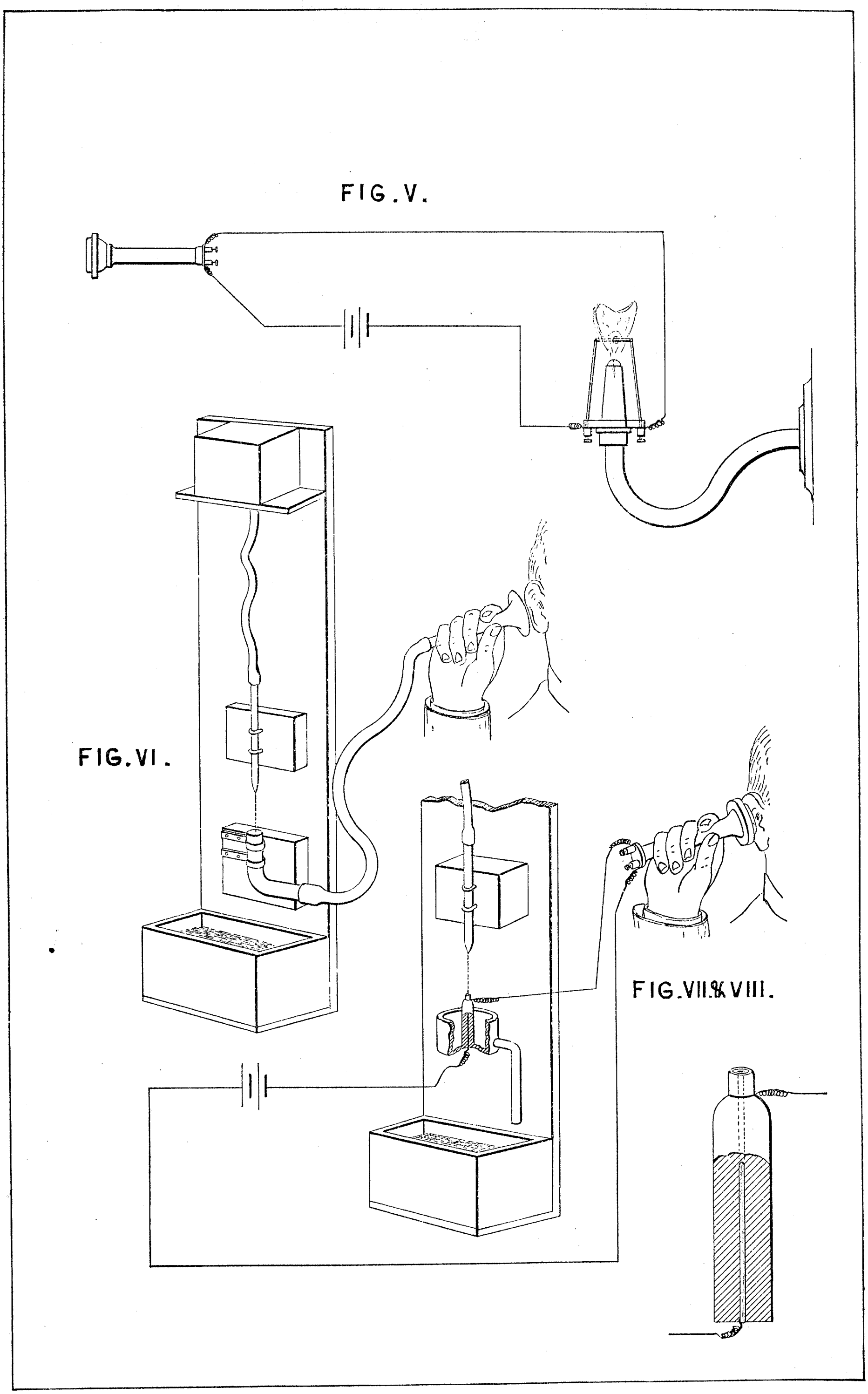


FIG. V.

FIG. VI.

FIG. VII. & VIII.

and reproducing all sounds whose pitch is below that of the jet normal, as well as some above; and that the timbre or quality of the impressed vibrations is also preserved, provided that the jet is at such pressure as to be capable of readily responding to all the overtones which confer this quality.

Other essential conditions for perfect reproduction are, that the receiving-membrane should be placed at such distance from the orifice that the jet never breaks into drops above its surface, and that it should be insulated as carefully as possible from the orifice.

In order to assist the action of aerial sound-waves on the fluid, it is advisable to attach the jet-tube rigidly to a pine sound-board about three-eighths of an inch thick. The surfaces of the board should be free, otherwise it may be supported in any way. The receiving-membrane is formed by a piece of thin sheet-rubber tied over the end of a brass tube about three-eighths of an inch in internal diameter. A wide flexible hearing-tube furnished with an ear-piece is attached to the brass tube. The jet-tube is connected with an elevated reservoir by an india-rubber pipe (fig. 6).

With an apparatus of this kind, and a tolerably wide jet-tube having an orifice about 0.7 mm. in diameter, a pressure of about 15 decimetres of water is required to bring the jet into condition to respond to all the tones and overtones of the speaking voice (except hissing sounds) and those employed in music. At a somewhat higher pressure it will reproduce hissing sounds. It is not easy for an untrained ear to distinguish between the disturbing sounds and their reproduction by the jet, when both are within range of hearing. Vibrations may, however, be conveyed to a jet from a distance in a fairly satisfactory way by attaching one end of a thin cord to the jet-support, and the other to the centre of a parchment drum. The cord being stretched, an assistant may speak, sing, or whistle to the distant drum. Other devices for conveying vibrations from a distance are described.

Now, when the jet is disturbed in any way, and the receiving-membrane is introduced into its path close to the orifice, scarcely any sound can be heard in the ear-piece; but, if the membrane be moved away from the orifice along the path of the jet, the sounds become gradually louder, until at a certain distance (which varies both with the character of the orifice and the intensity of the impressed vibrations) a position of maximum purity and loudness is reached. At greater distances the reproduction by the jet becomes at first rattling and harsh, and finally unintelligible. In the latter case the jet will be seen to break above the membrane.

From this experiment we may draw the conclusions previously arrived at for air-jets; viz., that all changes produced by sound at the orifice grow in accordance with the same law; and that all changes travel with the same velocity, which is probably the mean velocity of the stream.

The mode in which the jet acts upon the membrane becomes apparent when instantaneous shadow-photographs of vibrating jets are examined. When the jet is steady, and the orifice strictly circular and well insulated, the outline in the upper part of the stream is that of a slightly conical rod, the base of the cone being at the orifice. When, however, vibrations are impressed upon the support, swellings and constrictions appear on the surface of the rod, which become more pronounced as the fluid travels downwards. At the breaking-point the constrictions give way, those due to the more energetic sound-impulses being the first to break. When the impressed vibrations are complex, the outline of the jet may be very complicated. When the membrane is interposed, we have then a constantly changing mass of liquid hurled against it, and vibratory movements are therefore excited in it, proportional to the varying cross-section of the jet at its surface.

It would appear at first sight that the mode of growth of the vibratory changes in a liquid jet must be different from that which characterizes the vibrations of an air-jet. It is possible, however, by special arrangements, to receive the impact of only a small section of a vibrating liquid jet, and thus to get a reproduction of its vibrations as sound. We are thus led to conclude that the sound-effects of a vibrating liquid jet may not be simply due to its varying cross-section, since actual changes occur in the translation- or rotation-velocity of its particles. Experiment shows that these changes are greatest along the axis of the jet.

One of the most interesting and beautiful methods of studying the vibrations of a jet consists in placing some portion of it in circuit with a battery and telephone, whereby its vibrations become audible in the telephone. A number of forms of apparatus for this purpose have been constructed, but one will serve as a type. Savart, in the course of his experiments, showed that the vibrations of the jet are preserved in the 'nappe,' or thin sheet of fluid formed when the jet strikes normally on a small surface. So far, then, as vibratory changes are concerned, the nappe has all the properties of the main stream. Although the diameter of this excessively thin film is about the same whatever be the distance of the surface from the orifice, the intensity of the vibratory changes propagated to it varies with this distance, as for the jet itself. It is simply necessary, then, to insert into the nappe two platinum electrodes in circuit with a telephone and a battery having an electromotive force of from twelve to thirty volts, to get an accurate and faithful reproduction of the jet-vibrations. Loud sounds can thus be obtained from a jet which is finer than the finest needle, and the arrangement constitutes a highly sensitive 'transmitter' (figs. 7 and 8).

A jet-transmitter, in its simplest form, consists essentially of a glass jet-tube which is rigidly attached to a sound-board, and supplied from an elevated reservoir containing some conducting-liquid (distilled water acidified with one three-hundredth of its volume of pure sulphuric acid is the best), and a couple of platinum electrodes embedded in an insulator, such as ebonite, against which the jet strikes. The jet may issue from a circular orifice, about 0.25 mm. in diameter, in the blunt and thin-sided end of a small glass tube. Much smaller jets may be used, but, for one of the given size, the pressure required for distinct transmission of all kinds of sounds will not exceed thirty inches. The receiving-surface is the rounded end of an ebonite rod, through the centre of which passes a platinum wire. The upper end of the rod should be about 1 mm. in diameter, and should be surrounded by a little tube of platinum; and the end of the central wire and the upper margin of the tube should form a continuous slightly convex surface with the ebonite, free from irregularities. The inner and outer platinum electrodes are joined respectively to the terminals of the circuit. The jet is allowed to strike on the end of the central wire, and, thence radiating in the form of a nappe, comes into contact with the tube, thus completing the circuit. The dimensions of the apparatus may be varied to suit jets of different sizes; it is highly desirable, however, that the jet nappe should well overlap the inner margin of the ring-shaped electrode.

With small jets the impact disturbances are so feeble, that slight precautions are necessary to insulate the receiving-surface from the orifice, unless the former is placed low down in the path. The strength of battery may be increased until the escape of electrolytic gas-bubbles causes a faint hissing noise in the telephone. The liquid, on its way to the jet, should pass downwards through a wide tube lightly packed with coarse clean cotton, by which minute air-bubbles which violently disturb the jet, and small particles of dust which might obstruct the orifice, are stopped. This tube should never be allowed to empty itself.

Experiments are given to show that in this instrument the jet may act upon the electric current in two ways: first, by interposing a constantly changing liquid resistance between the electrodes; and, second, by causing changes in the so-called 'polarization' of the electrodes. In one form of instrument, namely, that in which both jet and electrodes are entirely immersed in a mass of liquid of the same kind as the jet liquid, the action must be entirely at the surface of the electrodes.

In the latter case a liquid jet becomes similar in structure and properties to a jet of air in air, and the velocity at different points when it is steady and when it is disturbed varies in precisely the manner already described.

The author briefly passed in review the leading facts to be accounted for, and laid stress upon the parallelism of the properties of gaseous and liquid jets. Some shadow-photographs of vibrating smoke jets have shown that these also present drop-like swellings and contractions which grow along the jet-path. The most satisfactory explanation of the phenomena will then be one which refers the vibratory changes in jets of both kinds to the same origin.

The beautiful and well-known experiments of Plateau have supplied a satisfactory explanation of the normal vibrations of a liquid jet in air. He has shown that a stationary liquid cylinder, whose length exceeds a certain multiple of its diameter, must break up, under the influence of the 'forces of figure,' into shorter cylinders of definite length, which, when liberated, tend to contract into drops. Now, the jet being regarded as such a stationary cylinder, we have a satisfactory explanation of the musical tone resulting when its discontinuous part strikes upon a stretched membrane, and when the impact disturbances may be in any way conducted back to the orifice. These disturbances then accelerate the division of the jet after it leaves the orifice. Plateau endeavored to show that division of the jet might take place at other than the normal points, thus explaining Savart's conclusion that a jet can vibrate in sympathy with a limited range of tones. Lord Rayleigh, moreover, has recently shown that the inferior limit of this range is not so sharply defined theoretically as Savart's experiments would prove it to be.

Both Savart and Magnus, however, describe experiments in which a water-jet, carefully protected from impact and other disturbances, does not exhibit the peculiar appearances characteristic of rhythmical division; and the author's experiments conclusively prove that this rhythmical division does not take place in a well-insulated jet. While the tendency so to divide may therefore be admitted, and the normal rate of vibration of the jet and its greater sensitiveness to particular tones may thereby be explained, Plateau's theory cannot be held to account for the uniform growth, along the jet-path, of all changes, however complex their form; for this growth takes place independently of the 'forces of figure,' and under conditions in which they are entirely absent, as when a gaseous or liquid jet plays within a mass of fluid of its own kind.

The author is inclined, rather, to refer the properties of jets of all kinds to conditions of motion on which hitherto little stress has been laid; viz., the unequal velocities at different points in the stream after it has left the orifice. From the axis towards the circumference of a jet near the orifice, the velocity diminishes continuously, and the motions of the stream may be regarded as resultants of the motions of an infinite series of parallel and co-axial vortex-rings. In many respects, in fact, the appearance of a jet resembles the appearance of a vortex-ring projected from the same orifice. Thus a jet from a circular orifice, like a vortex-ring from a round aperture, remains always circular. In a frictionless fluid a vortex-ring, uninfluenced by other vortices, would remain of constant diameter, — a condition to which a horizontal liquid jet approximates. When, however, the ring moves through a viscous fluid, it experiences retardation and expansion, which are precisely the changes which a jet playing in a fluid of its own kind undergoes. The vibrating smoke-ring projected from an elliptical aperture changes its form in exactly the same manner as a jet, at sufficiently low pressure, from an elliptical orifice. These analogies might be considerably extended.

In a liquid jet in air or in a vacuum, internal friction must gradually equalize the velocities. At a distance from the orifice, therefore, depending on the viscosity of the liquid, such a jet must approach the condition of a cylinder at rest, and must tend to divide in accordance with Plateau's law. The rapidity with which drops are formed depends mainly on the superficial tension of the liquid. The length of the continuous column should therefore bear some inverse ratio to the viscosity and superficial tension of the liquid, — a view which is in harmony with the results of Savart's experiments, and some of the author's, in this direction.

Where the jet plays into a fluid of its own kind, the retardation and expansion which it experiences are mainly due to its parting with its energy to the surrounding medium. When, as a result of vibration, growing swellings and contractions are formed in it, this loss must be more rapid; and the jet therefore shows a diminution of mean velocity along the axis, which increases with the distance from the orifice.

Such being the conditions, it is evident that any impulse communicated to the fluid, either behind or external to the orifice, or to the orifice itself, must alter the vorticity of the stream. That vortex-rings are generated by impulses of the first kind is well known; the action when the orifice is moved is intelligible, if we consider that a forward motion of it will produce acceleration, a backward motion retardation, of the outer layers of the jet. As the result of a rapid to-and-fro motion, we may then imagine two vortex-rings to be developed; the foremost layer of greater energy, and moving more slowly, than the hindmost. These two rings, in their onward course, will then act on each other in a known manner: the first will grow in size and energy at the expense of the second, at the same time diminishing in velocity; the second will contract while its velocity increases. The inequalities in cross-section, initiated at the orifice, thus tend to grow along the jet-path, and will be attended also by growing inequalities of the normal and rotational velocities of the particles. Since the stream-lines of a vortex-ring are crowded together at its centre, the disturbances produced by impact of the jet-rings will be greatest along the axis, and least along the circumference.

Indeed, the sound disturbances produced by impact of a common vortex-ring are quite analogous to those of a vibrating jet. Let an air-ring be projected into a trumpet-shaped tube connected with the ear, and little more than a rushing noise will result; but let it be projected against a small orifice in the hearing tube, and a sharp click will be heard at the moment of impact. This click is loud when the centre of the ring strikes the tube, but faint, although still of the same character, when produced from the circumference.

The foregoing considerations may be extended to cases in which the motions of the orifice are complex vibrations. Expansions and contractions are then initiated in the fluid proportional at every point to the velocity of the orifice. The inequalities must tend to further diverge in the manner described.

Similar considerations apply to cases in which the motions of the orifice are the result of lateral impulses. In these cases the rings formed in the jet will not be perpendicular to its direction, and in their onward course may possibly vibrate about a mean position.

The author further pointed out how the viscosity and surface-tension of the fluid may influence its sensitiveness. When the surface-tension is very high, as in mercury, it produces a tendency in the jet to break easily under the influence of moderate impulses.

The foregoing is ttle m ore than the outlines of a new theory of jet-vibrations. The author hopes to supply in the future further experimental evidence in support of it.

BOSTON LETTER.

EVIDENTLY one should join the Essex institute in Salem if one wishes to live to a green old age. This well-honored scientific body held its annual meeting recently; and the secretary's report showed, that, of the 24 deaths during the year, all but one were of persons over fifty years of age. Moreover, of the 324 living members, two-thirds are over threescore years and ten, and seven are past fourscore. The institute is soon to go into new quarters.

Preparations are making for the celebration at Cambridge of the two hundred and fiftieth anniversary of the founding of Harvard college. It will not take place at the commencement season, but at some time the following autumn, and it seems to be generally understood that Hon. James Russell Lowell will preside. It will be a different thing from the bicentenary, when a smaller audience-room than is now available permitted even all the undergraduates to find a place. The living Harvard alumni alone are probably three times the number living fifty years ago, and certainly the undergraduates are five times as numerous as then. This event makes specially appropriate the list just published by the university, showing the literary activity of its officers during the last five years. A similar ten-years list was published in 1880; but the present, though only for half that time, not only contains a longer list of publications than the former, but a somewhat larger number of writers among the officers.

Gifts continue to come in to the university. Mrs. Draper of New York continues to further the researches to which the late Dr. Henry Draper devoted his life. Her latest gift is of a thousand dollars to Harvard college observatory, to be expended under the direction of Professor Pickering in prosecuting researches in the photography of stellar spectra; the eleven-inch photographic lens constructed by Dr. Draper will be employed in this work, and those who heard Professor Pickering's account, at the Albany meeting of the National academy last autumn, of his own work in the field in which Dr. Draper's name is so honorably associated, will believe that Mrs. Draper has made an excellent choice.

In this same connection it should be mentioned that the contest at law about the Paine bequest to the Harvard observatory, mention of which has before been made in this correspondence, is happily closed by amicable settlement between the parties concerned. The amount which will now be turned over to the observatory, probably within the next month or two, will scarcely differ from that previously announced, and on the death of the widow it is probable that the entire bequest will exceed three hundred thousand dollars. Those who have followed the telling activity of the observatory under its present management will be confident that no other institution could make better use of such a noble gift.

At the annual meeting of the American academy, May 25, it was voted to present the Rumford gold and silver medal to Professor Langley of the Allegheny observatory, for his researches in radiant energy. Thus Professor Langley has in a single year borne off the two principal gold medals given for scientific work in America, having received the Draper medal of the National academy only last month. No one will dispute his right to them. The Rumford fund will also be used this year by the American academy in aid of researches upon the solar corona at the time of the total eclipse of August next, five hundred dollars having been appropriated in aid of Mr. W. H. Pickering's expedition to the West Indies. A letter was read from Mr. Greenough the sculptor, a fellow of the academy, announcing his gift to the academy of a portrait of Galileo, which he stated was either an old copy or a replica of the portrait in the Pitti palace. The portrait is already on its way to America.

In passing through Mount Auburn cemetery the other day I observed for the first time the monument which has been erected at the grave of Pourtalès, the colleague of Agassiz, and the pioneer in the zoölogy of the deep seas. It is a simple but massive semicircular slab of very fine-grained sandstone, on one face of which is the usual inscription, while on the other, facing the grave, has been deeply engraved a conventionalized Pecten-like sea-shell, forming a sort of niche; and on the surface of this are neatly sculptured in bas-relief a coral, a Comatula, a Gorgonia, and a magnified foraminifer, emblematic of the subjects of his study.

Ths topographical field-parties of the U. S. geological survey have begun their season's operations in this state, and before next winter most of the field-work will have been finished. The Appalachian mountain club, taking advantage of the work already completed, is about to issue, by permission of the survey, a photolithograph of a portion of the field-sheets on the original scale, comprising the extreme north-western corner of