case of inflammation of the arachnoid. Death occurred after the fourth injection, and Prof. Virchow has never seen so intense a hyperæmia of the pia mater and brain as this case presented. After careful examination no regressive changes could be found in the tubercular tissues.

The inflammatory changes met with in the various cases were not confined to a simple hyperæmia, which might possibly be regarded as of a transitory nature, but tissue changes which promised to be of a more lasting nature were also to be met with. The lymph glands near the affected parts, for instance, were found to be greatly enlarged. The increase in size seems due to a rapid multiplication of the cells in the medullary part of the gland—a change which is characteristic of acute irritations. This is probably connected with the increase in the number of white blood-corpuscles that has frequently been found to follow lymph injections, and this, again, with the frequent infiltration by leucocytes of affected parts and their surrounding tissues.

The changes produced in the lungs themselves belong to two widely different categories. Firstly, comes "caseous hepatization." That this can be actually caused by the injections is rendered highly probable by a very striking case, in which infiltration only commenced after the treatment had ceased, and led to a caseous hepatization of almost unique extent. Six injections had been made on this patient, of which the last was made four weeks before his death. Secondly, a "catarrhal pneumonia" is met with, sometimes alone, sometimes accompanied by the first-mentioned change. This form of pneumonia differs from ordinary catarrhal pneumonia in that it seems to lead to a rapid destruction of the lung-parenchyma, and a sort of cavity formation.

The most important conclusion that Prof. Virchow puts forward is that the formation of new tubercles which has been met with in many of these fatal cases must be ascribed with great probability to the action of the lymph itself.

The appearance of new tubercles has already been observed in lupus and tuberculosis of the larynx. Hitherto it has been asserted that the changes in question were merely due to the action of the lymph on tubercular material latent in the apparently healthy tissues. This view appears to be no longer tenable, at any rate as a general explanation. On serous membranes, which Virchow has always regarded as being best fitted for the observation of the early stages of tuberculosis, perfectly new submiliary tubercles have been found, under conditions which make it scarcely probable that they dated from an earlier stage of the disease. All these tubercles were perfectly intact, even in cases in which the injections had been made several weeks before. There was nothing to support the suggestion that these tubercles had been in any way affected or harmed by the action of the lymph.

How can this outbreak of new tubercles be explained?

In a phthisical case which terminated fatally, four small tubercles, surrounded by a zone of well-marked hyperæmia, were found situated on a part of the pericardium that could in no way come into contact with the lungs. In this case a direct infection was impossible, and we must suppose that, owing to the action of the lymph in breaking down the tubercular masses in the lungs, tubercle bacilli were thrown into the circulation, and thus reached the pericardium, where they succeeded in producing a metastatic infection.

In consequence of these and other similar observations, Prof. Virchow comes to the conclusion that the lymph should not be employed in cases in which one would expect some difficulty in excreting the tubercular matter set free by the treatment.

In forming an opinion as to the clinical bearing of these *post-mortem* appearances, it must be borne in mind that most, if not all, of these fatal cases were already in an advanced stage before they came under treatment; and, from the practical point of view, Virchow's work merely adds to the evidence that is gradually accumulating in the Berlin clinics, of the unsuitability of Koch's lymph for advanced cases, at all events with the present methods of administration.

For other considerations arise besides that of the stage of the disease. Thus I have good reason for believing that Koch's treatment of consumption has been less successful at the Charité (in which hospital Virchow's twenty-one cases have occurred) than in the other hospitals and clinics of Berlin. It would be interesting to determine whether any difference in the details of the treatment at the various hospitals could help to explain the difference in the results. The quantities of lymph employed and the frequency of the injections are by no means uniform in the various hospitals. For example, the Charité and the Friederichshain appear to stand at the opposite ends of the scale in these respects. For the following details respecting these hospitals I am indebted to a friend, who during the last month has been studying the results in the various clinics. At the Charité the injections appear to be administered more frequently and with a more rapid increase in the size of the doses than is the custom in the Friedrichshain Hospital. Further, the largest dose administered to a patient at Friedrichshain seems almost always below that given at the Charité, whilst the average dose given at the latter hospital also seems generally larger. Naturally, it would be unwise to draw definite conclusions until the details of such a comparison have been thoroughly investigated, but whatever the explanation may be, I have good reasons for asserting that the results obtained at Friedrichshain have been far more favourable than those obtained at the Charité. Not only do the milder cases seem to have made better progress at the former hospital, but the severer cases have less often had a fatal termination.

It would thus appear as if the dosage alone has a considerable influence upon the results obtained, even in the advanced cases which alone are the subject of Prof. Virchow's animadversion. E. H. HANKIN.

THE RESEARCHES OF DR. R. KŒNIG ON THE PHYSICAL BASIS OF MUSICAL SOUNDS.[1]

III.

A FINAL proof, if such were needed, is afforded by an experiment, which, though of a striking character, will not necessarily be heard by all persons present, being only well heard by those who sit in certain positions. If a shrill tuning-fork is excited by a blow of the steel mallet, and held opposite a flat wall, part of the waves which it emits strike on the surface, and are reflected. This reflected system of waves, as it passes out into the room, interferes with the direct system. As a result, if the fork, held in the hand be moved toward the wall or from it, a series of maxima and minima of sound will successively reach an ear situated in space at any point near the line of motion, and will be heard as a series of beats; the rapidity with which they succeed one another being proportional to the velocity of the movement of the fork. The fork Dr. Kœnig is using is ut_6, which gives well-marked beats, slow when he moves his arm slowly, quick when he moves it quickly. There are limits to the speed at which the human arm can be moved, and the quickest speed that he can give to his fails to make the beats blend to a tone. But if he will take sol_6, vibrating $1\frac{1}{2}$ times as fast, and strike it, and move it away from the wall with the fastest speed that his arm will permit, the

[1] By Prof. Silvanus P. Thompson. (Communicated by the author having been read to the Physical Society of London, May 16, 1890.) Continued from p. 227.

beats blend into a short low growl, a non-uniform tone of low pitch, but still having true continuity.

This first portion of my account of Dr. Kœnig's researches may then be summarized by saying that in all circumstances where beats, either natural or artificial, can be produced with sufficient rapidity, they blend to form a beat-tone of a pitch corresponding to their frequency.

I now pass to the further part of the researches of Dr. Kœnig which relates to the timbre of sounds. Prior to the researches of Dr. Kœnig, it had been supposed that in the reception by the ear of sounds of complex timbre the ear took no account of, and indeed was incapable of perceiving, any differences in phase in the constituent partial tones. For example, in the case of a note and its octave sounded together, it was supposed and believed that the sensation in the ear, when the difference in phase of the two components was equivalent to one-half of the more rapid wave, was the same as when that difference of phase was one-quarter, or three-quarters, or zero. I had myself, in the year 1876, when studying some of the phenomena of binaural audition, shown reason for holding that the ear does nevertheless take cognizance of such differences of phase. Moreover, the peculiar rolling or revolving effect to be noticed in slow beats is a proof that the ear perceives some difference due to difference of phase. Dr. Kœnig is, however, the first to put this matter on a distinct basis of observations. That such differences of phase occur in the tones of musical instruments is certain: they arise inevitably in every case where the sounds of subdivision are such that they do not agree rigidly with the theoretical harmonics. Fig. 5 depicts a graphic record taken by Dr. Kœnig from a vibrating steel wire, in which a note and its octave had been simultaneously excited. The two sounds were scarcely perceptibly different from their true interval, but the higher note was just sufficiently sharper than the true harmonic octave to gain about one wave in 180. The graphic trace has in Fig. 5 been split up into 5 pieces to facilitate insertion in the text. It will be seen that as the phase gradually changes the form of the waves undergoes a slow change from wave to wave. Now, it is usually assumed that in the vibrations of symmetrical systems, such as stretched cords and open columns of air, the sounds of subdivision agree with the theoretical harmonics. For example, it is assumed that when a stretched string breaks up into a nodal vibration of four parts, each of a quarter its length, the vibration is precisely four times as rapid as the fundamental vibration of the string as a whole. This would be true if the string were absolutely uniform, homogeneous, and devoid of rigidity. Strings never are so; and even if uniform and homogeneous, seeing that the rigidity of a string has the effect of making a short piece stiffer in proportion than a long piece, cannot emit true harmonics as the sounds of subdivision. In horns and open organ-pipes the width of the column

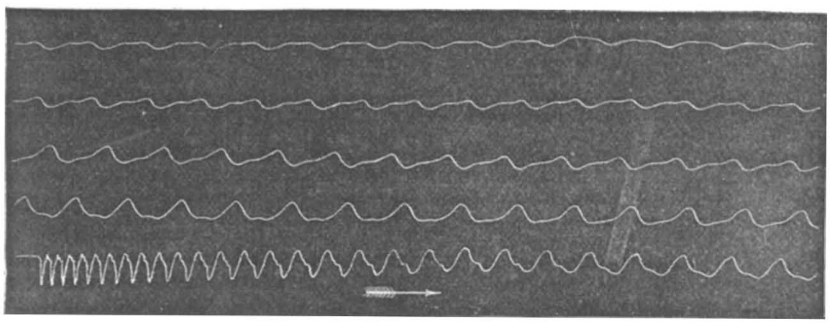

FIG. 5.

(which is usually neglected in simple calculations) affects the frequency of the nodal modes of vibration. Wertheim found the partial tones of pipes higher than the supposed harmonics.

These things being so, it is manifestly insufficient to assume, as von Helmholtz does in his great work, that all timbres possess a purely periodic character; with the necessary corollary that all timbres consist merely in the presence, with greater or less intensity, of one or more members of a series of higher tones corresponding to the terms of a Fourier series of harmonics. When, therefore, following ideas based on this assumption, von Helmholtz constructs a series of resonators, accurately tuned to correspond to the terms of a Fourier series (the first being tuned to some fundamental tone, the second to one of a frequency exactly twice as great, the third to a frequency exactly three times, and so forth), and applies such resonators to analyze the timbres of various musical and vocal sounds, he is trying to make his resonators pick up things which in many cases do not exist—upper partial tones which are exact harmonics. If they are not exact harmonics, even though they exist, his tuned resonator does not hear them, or only hears them imperfectly, and he is thereby led into an erroneous appreciation of the sound under examination.

Further, when in pursuance of this dominant idea he constructs a system of electro-magnetic tuning-forks, accurately tuned to give forth the true mathematical harmonics of a fixed series, thinking therewith to reproduce artificially the timbres not only of the various musical instruments but even of the vowel sounds, he fails to reproduce the supposed effects. The failure is inherent in the instrument; for it cannot reproduce those natural timbres which do not fall within the circumscribed limits of its imposed mathematical principle.

Nothing is more certain than that in the tones of instruments, particularly in those of such instruments as the harp and the pianoforte, in which, the impulse, once given, is not sustained, the relations between the component partial tones are continually changing, both in relative intensity and in phase. The wavelets, as they follow one another, are ever changing their forms: in other words, the motions are not truly periodic—their main forms may recur, but with modifications ever changing.

To estimate the part played in such phenomena by mere differences of phase—to evaluate, in fact, the influence of phase of the constituents upon the integral effect of a compound sound—Dr. Kœnig had recourse to the *wave-siren*, an earlier invention of his own, and of which the wave-disks which have already been shown are examples.

In the first place, Dr. Kœnig proceeded synthetically to construct the wave-forms for tones consisting of the resultant of a set of pure harmonics of gradually decreasing intensity. The curves of these, up to the tenth member of the series, were carefully compounded graphically: first with zero difference of phase, then with all the upper members shifted on one quarter, then with a difference of a half-wave, then with a difference of three-quarters. The results are shown in the top line of curves in Fig. 6, wherein it will be noticed that the curve for difference of phase = $\frac{1}{2}$ is like that for zero difference, but reversed, left for right; and that the curve for difference of phase = $\frac{3}{4}$ is like that for difference = $\frac{1}{4}$, but inverted. Now, according to von Helmholtz, the sounds of all these four curves should be precisely alike, in spite of their differences of form and position. To test the matter, these carefully-plotted curves were set out upon the circumference of a cylindrical band of thin metal, the edge being then cut away, leaving the unshaded portion, the curve being repeated half a dozen times, and meeting itself after passing round the circumference. For convenience, the four curves to be compared are set out upon the separate rims of two such metallic cylindrical hoops, which are mounted upon one axis, to which a rapid motion of rotation can be imparted, as shown in Fig. 7. Against the dentellated edges of these rims, wind can be blown through narrow slits connected to the wind-chamber of an organ-table. In the apparatus (Fig. 7) the four curves in question are the four lowest of the set of six. It will be obvious that, as these curves pass in front of the slits from which wind issues, the maximum displacement of air will result when the slit is least covered, or when the point of greatest depression of the curve crosses the front of the slit. The negative ordinates of the curve correspond, therefore, approximately to condensations. Air is now being supplied to the slits; and when I open one or other of the valves which control the air-passages, you hear one or other of the sounds. It must be audible to everyone present that the sound is louder and more forcible with a difference of phase of $\frac{1}{4}$ than in any other case, that produced with $\frac{3}{4}$ difference being gentle and soft in tone, whilst the curves of phase 0 and $\frac{1}{2}$ yield tones of intermediate quality. Dr. Kœnig found that, if he merely combined together in various phases a note and its octave (which was indeed the instance examined by me binaurally in 1876), the loudest resultant sound is given when the phase-difference of the combination is $\frac{1}{4}$, and the mildest when it is $\frac{3}{4}$.

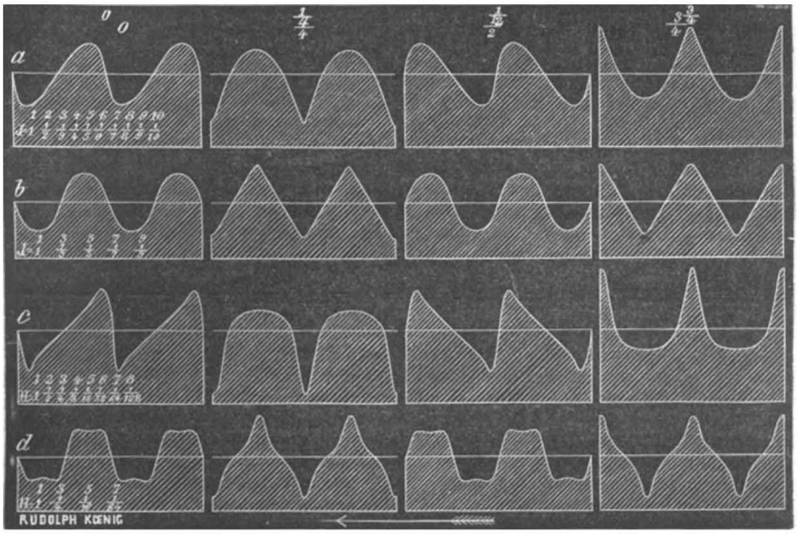

FIG. 6.

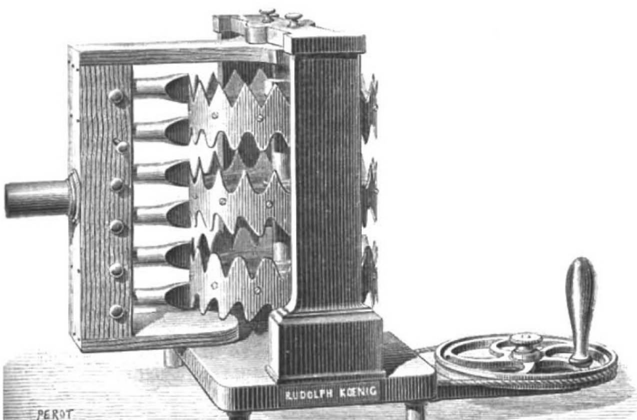

FIG. 7.

Returning to Fig. 6, in the second line are shown the curves which result from the superposition of the odd members only of a harmonic series of decreasing amplitude. On comparing together the curves of the four separate phases, it is seen that the form is identical for phases 0 and $\frac{1}{2}$, which show rounded waves, whilst for phases $\frac{1}{4}$ and $\frac{3}{4}$ the forms are also identical, but with sharply angular outline. These two varieties of curve are set out on the two edges of the highest metallic circumference in the apparatus depicted in Fig. 7. The angular waves are found to yield a louder and more strident tone than the rounded waves, though, according to von Helmholtz, their tones should be alike.

A much more elaborate form of compound wave-siren was constructed by Dr. Kœnig for the synthetic study of these phase-relations. Upon a single axis, one behind the other is mounted a series of 16 brass disks, cut at their edges into sinusoidal wave-forms. These represent a harmonic series of 16 members of decreasing amplitude, there being just 16 times as many small sinuosities on the edge of the largest disk as there are of large sinuosities on that of the smallest disk. A photograph of the apparatus is now thrown upon the screen. It is described fully by Dr. Kœnig in his volume "Quelques Expériences," and was figured and described in NATURE, vol. xxvi. p. 277. Against the edge of each of the 16 wave-disks wind can be separately blown through a slit. This instrument therefore furnishes a fundamental sound with its first fifteen pure harmonics. It is clear that any desired combination can be obtained by opening the appropriate stops on the wind-chest; and there are ingenious arrangements to vary the phases of any of the separate tones by shifting the positions of the slits. The following are the chief results obtained with this instrument. If we first take simply the fundamental tone and its octave together, the total resultant sound has the greatest intensity when the difference of phase $\delta=\frac{1}{4}$ (*i.e.* when the maximum displacement of air occurs at the same instant for both waves); and at the same time the whole character of the sound becomes somewhat graver, as if the fundamental tone predominated more than in other phases. The intensity is least when $\delta=\frac{3}{4}$. If, however, attention is concentrated on the octave note while the phase is changed, its intensity seems about the same for $\delta=\frac{1}{4}$ as for $\delta=\frac{3}{4}$, but weaker in all other positions. The compound tones formed only of odd members of the series have always more power and brilliancy of tone for phase differences of $\frac{1}{4}$ and $\frac{3}{4}$, than for 0 and $\frac{1}{2}$; but the quality for $\frac{1}{4}$ is always the same as for $\frac{3}{4}$, and the quality for 0 is always the same as for $\frac{1}{2}$. This corresponds to the peculiarity of the corresponding wave-form, of which the fourth line of curves in Fig. 6 is an example. For compound tones corresponding to the whole series, odd and even, there is, in every case, minimum intensity, brilliancy, and stridence with $\delta=\frac{3}{4}$, and maximum with $\delta=\frac{1}{4}$. Inspection of the first and third lines of curves in Fig. 6 shows that in these wave-forms that phase which is the most forcible is that in which the maximum displacement, and resulting condensation, is sudden and brief.

Observing that wave-forms in which the waves are asymmetrical—steeper on one side than on the other—are produced as the resultant of a whole series of compounded partial tones, it occurred to Dr. Kœnig to produce from a perfect and symmetrical sinusoidal wave-curve a complex sound by the very simple device of turning into an oblique position the slit through which the wind was blown against it. In Fig. 8 is drawn a simple sym-

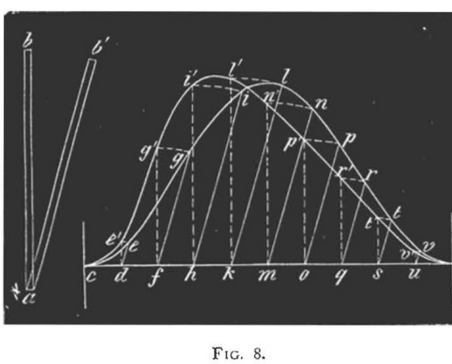

FIG. 8.

metrical wave-form, *eglnprtv*. If a series of such wave-forms is passed in front of a vertical slit, such as *ab*, a perfectly simple tone, devoid of upper partials, is heard. But by inclining the slit, as at *ab'*, the same effect is produced as if the wave-form had been changed to the oblique outline *e'g'l'n'p'r't'v'*, the slit all the while remaining upright. But this oblique form is precisely like that obtained as resultant of a decreasing series of partial tones (Fig. 6, *a*). If the slit be inclined in the same direction as the forward movement of the waves, the quality produced is the same as if all the partial tones coincided at their origin, or with $\delta = 0$; while if inclined in the opposite direction the quality is that corresponding to $\delta = \frac{1}{2}$. It is easy to examine whether the change of phase produces any effect on the sound. Before you is rotating a simple wave-disk, and air is being blown across its edge through a slit. Dr. Kœnig will now tilt the slit alternately backward and forward. On tilting the slit forward to give $\delta = 0$, you hear a purer and more perfect sound; and on tilting it back, giving $\delta = \frac{1}{2}$, a sound that is more nasal and forcible.

All the preceding experiments agree then in showing that differences of phase do produce a distinct effect upon the quality of compound tones: what then must we say as to the effect on the timbre of the presence of upper partial tones or sounds of subdivision that do not agree with any of the true harmonics? A mistuned harmonic—if the term is permissible—may be looked upon as a harmonic which is undergoing continual change of phase. The mistuned octave which yielded the graphic curve in Fig. 5 is a case in point. The wavelets are continually changing their form. It is certain that in a very large number of musical sounds, instrumental and vocal, such is the case.

It was whilst experimenting with his large compound wave-siren that Dr. Kœnig was struck by the circumstance that under no conditions, and by no combination of pure harmonics in any proportion of intensity or phase, could he reproduce any really strident timbres of sound, like those of harmonium reeds, trumpets, and the like; nor could he produce satisfactory vowel qualities of tone. Still less can these be produced satisfactorily by von Helmholtz's apparatus with electro-magnetic tuning-forks, in which there is no control over the phases of the components. The question was therefore ripe for investigation whether for the production of that which the ear can recognize as a *timbre*, a definite unitary quality of tone, it was necessary to suppose that all the successive wavelets should be of similar form. Or, if the forms of the successive wavelets are continually changing, is it possible for the ear still to grasp the result as a unitary sensation?

If the ear could always separate impure harmonic or absolutely inharmonic partials from their fundamental tone, or if it always heard pure harmonics as an indistinguishable part of the unity of the timbre of a fundamental, then we might draw a hard and fast line between mere mixtures of sound and timbres, even as the chemist distinguishes between mere mixtures and true chemical compounds. But this is not so: sometimes the ear cannot unravel from the integral sensation the inharmonious partial; on the other hand, it can often distinguish the presence of truly harmonious ones. Naturally, something will depend on the training of the ear; as is the case with the conductor of an orchestra, who will pick out single tones from a mixture of sounds which to less perfectly trained ears may blend into a unitary sensation.

Dr. Kœnig accordingly determined to make at least an attempt to determine synthetically how far the ear can so act, by building up specific combinations of perturbed harmonics or inharmonic partials, giving rise to waves that are multiform, as distinguished from the uniform waves of a true periodic motion. The wave-siren presented a means of carrying this attempt to a result. On the table before me lie a number of wave-disks constructed with this aim. This will be successively placed upon the whirling table, and sounded: but I must warn you that the proper effects will only be perceived by those who are near the apparatus, and in front of it.

Upon the edge of the first of the series there has been cut a curve graphically compounded of 24 waves as a fundamental, together with a set of four perturbed harmonics of equal intensity. The first harmonic consists of 49 waves (2 × 24 plus 1); the second of 75 waves

(3 × 24 plus 3); the third of 101 (4 × 24 plus 5); the fourth of 127 (5 × 24 plus 7). The resulting curve possesses 24 waves, no two of them alike in form, and some highly irregular in contour. The effect of blowing air through a slit against this disk is to produce a disagreeable sound, quite lacking in unitary character, and indeed suggesting intermittence.

The second wave-disk is constructed with the same perturbed harmonics, but with their amplitudes diminishing in order. This disk produces similar effects, but with more approach to a unitary character.

In the third disk there are also 24 fundamental waves, but there are no harmonics of the lower terms, the superposed ripples being perturbed harmonics of the fifth, sixth, and seventh orders. Their numbers are 6 × 24 plus 6; 7 × 24 plus 7; and 8 × 24 plus 8; being, in fact, three harmonics of a fundamental 25. This disk gives a distinctly dual sort of sound; for the ear hears the fundamental quite separate from the higher tones, which seem in themselves to blend to a unitary effect. There is also an intermittence corresponding to each revolution of the disk, like a beat.

The fourth disk resembles the preceding; but the gap between the fundamental and the three perturbed harmonics has been filled by the addition of three true harmonics. This disk is the first in this research which gives a real timbre, though it is a peculiar one: it preserves, however, a unitary character, even when the slit is tilted in either direction. The 24 waves in this disk all rake forward like the teeth of a circular saw, but with multiform ripples upon them. The quality of tone becomes more crisp when the slit is tilted so as to slope across the teeth, and more smooth when in the reverse direction.

The fifth disk, which is larger, has 40 waves at its edge; these are cut with curves of all sorts, taken hap-hazard from various combinations of pure harmonics in all sorts of proportions and varieties, no two being alike, there maxima and minima of the separate waves being neith isochronous nor of equal amplitude. This disk gives an entirely unmusical effect, amid which a fundamental tone is heard, accompanied by a sort of rattling sound made up of intermittent and barely recognizable tones.

The sixth disk is derived from the preceding by selecting eight only of the waves, and repeatiug them five times around the periphery. In this case each set of eight acts as a single long curve, giving beats, with a slow rotation, and a low tone (accompanied always by the rattling mixture of higher tones) when the speed is increased.

The seventh disk was constructed by taking 24 waves of perfect sinusoidal form, and superposing upon them a series of small ripples of miscellaneous shapes and irregular sizes, but without essentially departing from the main outline. This disk gives a timbre in which nothing can be separated from the fundamental tone, either with vertical or tilted slit.

The eighth and last disk consists of another set of 24 perfect waves, from the sides of which irregular ripples have been carved away by hand, with the file, leaving, however, the summits and the deepest parts of the hollows untouched, so that the maxima and minima are isochronous and of equal amplitude. This disk gives also a definite timbre of its own, a little raucous in quality, but still distinctly having a musical unity about it.

We have every reason, therefore, to conclude that the ear will recognize as possessing true musical quality, as a timbre, combinations in which the constituents of the sound vary in their relative intensity and phase from wave to wave.

What, then, is *a timbre?* Dr. Kœnig would be the first to recognize that these last experiments, though of deepest interest, do not afford a final answer to the question. We may not yet be in a position to frame a new definition as to what constitutes a timbre, but we may at least conclude that, whenever that definition can be framed, it will at least include several varieties, including the non-periodic kinds with multiform waves, as well as those that are truly periodic with uniform waves. We must not on that account, however, rush to the conclusion that the theory of von Helmholtz as to the nature of timbre has been overthrown. The corrections introduced into lunar theory by Hansen and Newcomb have not overturned the splendid generalizations of Newton. What we can and must confess is that we now know that the acoustic theory of von Helmholtz is, like the lunar theory of Newton, correct only as a first approximation. It has been the distinctive merit of Dr. Kœnig to indicate to us the magnitude of the correcting terms, and to supply us not only with a rich store of experimental facts but with the means of prosecuting the research synthetically beyond the point to which he himself has attained.

In thanking Dr. Kœnig for the courtesy which he has shown to this Society in bringing over his apparatus and in demonstrating its use to us, we must join in congratulating him on the patience, perspicacity, and skill with which he has carried out his researches. We know that his exceptional abilities as experimentalist and constructor have done more than those of any other investigator to make the science of experimental acoustics what it is to-day; and we must unite in wishing him long life and prosperity to complete the great work on which already he has advanced so far.

THE GEOLOGY OF ROUND ISLAND.

BOTANISTS have been a little perplexed as to the exact geological age of some of the islands in the Indian Ocean, and the current statements on the subject are by no means accordant. Any exact information on the subject seems, therefore, worth placing on record.

Round Island is a minute island, about two miles in diameter, which lies north-east of Mauritius, and about 13 miles distant. It was visited last November by Mr. William Scott, Assistant to the Director of Forests and Botanical Gardens, Mauritius, accompanied by Surgeon H. H. Johnston.

There is only one point where landing can be effected in calm weather; the end of November was therefore chosen for the visit as being the best season for landing. Unfortunately, the season at this time was very dry, so that the whole of the vegetation was in a dormant state, and little could be done in the way of procuring good specimens.

"The only trees," Mr. Scott writes, "of any size to be found on the island, are the Palms:—*Latania Loddigesii*, *Hyophorbe amaricaulis*, *Dictyosperma alba*, var. *aurea*, and the screw-pine *Pandanus Vandermeeschii*. These trees look stunted, and grow in clumps mixed up together where any root-hold is to be found. There were only at that time two or three grasses to be found, and these were in a very dry state. One or two Passifloras [probably introduced] and *Asclepiadaceæ* were also found. On these two latter, the wild goats which inhabit the island in hundreds, appear to exist."

Mr. Scott made a very careful collection of the rocks composing the island. His specimens were sent to Kew and were submitted to Prof. Judd, F.R.S., who very kindly examined them. He furnished me with the following report, which he has kindly allowed me to publish.

W. T. THISELTON DYER.

Royal Gardens, Kew, December 4.

Science Schools, South Kensington, S.W., September 29.

MY DEAR DYER,—Immediately upon my return to town I have, as I promised you, examined the specimens