paper before the Epidemiological Society last year on the subject. It is published in the Society's Transactions, and in a separate form by Mr. Lewis, of Gower Street. I also read a paper before the International Congress of Hygiene on antiseptic inunction. In this I have related the experience of other medical men in confirmation of my own. One, whose child had scarlet fever, placed his two other children in the same room, and kept them there for eight days, and they did not take the disease. This will be published in the Transactions of the Congress, and any one interested in the disinfection of infectious diseases, may obtain all the information they require from those two papers. J. BRENDON CURGENVEN.

Teddington Hall, S.W., August 17.

Alum Solution.

ONE frequently reads, in accounts of experiments on the physical or chemical action of luminous rays, that a *solution of alum* has been used to absorb obscure heat radiations. An instance of this occurs in your description of the investigation by M. D'Arsonval (NATURE, vol. xliv. p. 390). I should like to be informed if this practice is based upon actual evidence, or merely upon the supposition that, because alum itself cuts off a larger proportion of heat rays than any other easily available solid, its solution should be more effective than any other liquid. The only figures bearing on the question with which I am acquainted are those of Melloni, and he, as cited by Ganot, states the percentage of heat rays transmitted by alum solution as 12, and that by distilled water as 11. Why, then, not use distilled water? HARRY NAPIER DRAPER.

Dublin, August 27.

A NEW KEYED MUSICAL INSTRUMENT FOR JUST INTONATION.

ONE of those subjects which periodically turn up for discussion, and then vanish for an interval of neglect, is the possibility of obtaining just intonation in the performance of music. Those who have studied theory, properly so-called, know very well that the series of musical sounds commonly used, as expressed on the pianoforte, do not give the true harmonic combinations on which the art is based, and many zealous attempts have been made to cure the evil. One of these, showing some novelty and much merit, is now exciting the attention of eminent musicians on the Continent; it was mentioned briefly in NATURE of April 2 last (p. 521), and it may be interesting to many readers to give some further account of its general features. We may, however, preface this with a few words on the state of the question generally.

Although the equal division of the octave has now taken such a firm hold on modern musicians, it is only within a comparatively recent period that its use has become common. It was well known at an early date, but its defects checked its use until the general introduction of the class of instruments which have culminated in the pianoforte; the reason of its adoption then being that the want of sustaining power in the clavecin and the harpsichord so diminished the discordant effect as to make the faulty tuning endurable. People then began to get accustomed to it, and it was soon found that the system gave such extraordinary facilities for chromatic music, that the cultivation of this style became enormously developed. Hence the chromatic style and the equal temperament have become closely allied, and it is almost a matter of doctrine that the pianoforte division of the octave is a necessary element for the proper performance, or proper understanding, of the compositions of modern days.

For organs, the application of the equal temperament came much later. Down to about the middle of this century they were tuned on a system which gave the most usual keys fairly in tune, at the cost of an occasional harsh chord, which, for church purposes, was considered but a small price to pay for the general smooth and harmonious effect. But when highly skilled players began to increase, they required the organ to be more used for exhibition, and for this purpose the introduction of the equal temperament was deemed desirable. And so, as it thus commanded the two most powerful sources of music, it crept into use also by stringed instruments, orchestras, and voices, and so it has become general.

The consequence is that, now, practical musicians are in the habit of accepting the equal-tempered intonation as genuine and true music; and as the study of the principles of musical structure is by no means highly encouraged in this country, efforts are seldom made to undeceive them. Students are authoritatively told that questions about just intonation may be interesting to physicists and mathematicians as recondite problems in acoustical science, but that they have no bearing on "practical" music, and that, therefore, musicians need not trouble themselves about them. Some years ago, at a meeting of one of our musical educational establishments, it was said, "We do not here make music an affair of vibrations"—a sentiment which was received with loud applause.

No doubt some enthusiasts have carried the investigations on this subject to a degree of refinement which far outruns practical utility; and one can have little sympathy with those who delight in reviling and despising the duodecimal scale; seeing that it has been the means of materially advancing the art, and that the modern enharmonic system, founded upon it, has been so thoroughly incorporated into modern music that it is difficult to see how it could be now ignored.

But, on the other hand, one must, if one is to exercise reason and common-sense in musical matters, be equally at variance with the party who, arrogating to themselves the title of "practical" musicians, force on us the equal temperament to an extent which really means the extinction of true intonation altogether. We now, indeed, never hear it, and in fact only know by imagination what a true "common chord" means.

The principal objection to this state of things is that the ears of musicians become permanently vitiated, and lose the sense of accurate intonation, or the *desire to approach it*, which is tantamount to abandoning the most precious feature that modern music possesses—namely, beauty of harmony. A chord of well selected sounds, exactly in tune, is a very charming thing; but it is a thing unknown to ears of the present day. I can recollect the time when singers and violin-players strove to sing and play in good tune, and the effect of such unaccompanied part-singing, and such violin-playing, was very delightful. But now, music not being made "an affair of vibrations," one is often ashamed of the quality of what one hears; nobody seems to think purity of harmony, either with voices or violins or orchestras, to be a matter worth striving after.

It is surely a reasonable wish that this should be checked, but one must be reasonable in one's expectations. The pianoforte must certainly be let alone, and so must the organ when used for exhibitional purposes, though its cacophony under the present tuning detracts much from the pleasure of hearing such fine playing as is now common. But vocalists and violin-players ought to be encouraged, as of old, to sing and play in tune, and for this purpose what is wanted is an instrument which will keep up and circulate the tradition of what true music means. To attain this, therefore—*i.e.* to construct an instrument which shall enable a player, with moderate ease, to play polyphonic music, of moderately chromatic character, in strict tune—has been the aim of many ingenious musicians and mechanics.

I need not go into history. Everybody may see at South Kensington the wonderful enharmonic organ, built half a century ago by General Thompson, and may read of

the instruments described by Helmholtz, and his voluminous commentator, the late Dr. Ellis; and the efforts in the same direction of Mr. Colin Brown, and of Mr. Bosanquet, who has devoted much attention to the matter, are worthy of all praise. But my object now is to describe the latest attempt of the kind, by a native of Japan, Dr. Shohé Tanaka. Persons who have lately had to do with that country have been well aware, not only of the natural ingenuity of the Japanese, but of the high standing which many of their youth have taken in scientific studies. Dr. Tanaka combines these two qualifications. After an industrious preliminary education in his own country, he went to Berlin, where he has been for five years studying physical and mechanical science under the best professors, and with these he has combined also a study of music. He has published, in the *Viertel-jahrsschrift für Musikwissenschaft* for 1890, a long essay on the subject generally, which fully demonstrates his knowledge of it; and he appears to have made a very favourable impression in Germany. He exhibited his "Enharmonium," as it was called, to the Emperor and Empress, and he produces testimonials from many musicians of the highest rank, among whom are Joachim, Von Bülow, Reinecke, Richter, Fuchs, Moszkowski, the whole staff of the Leipzig Conservatoire of Music, and many others. These not only speak highly of the instrument, but (in strong contrast to the English authorities) earnestly support and recommend the object it is proposed to serve. Indeed, some of the testimonials are essays on the advantage of the cultivation of pure intonation. Von Bülow especially says:—

"I have requested the maker to make me such an enharmonium for my personal use at home. I am earnestly desirous to protect myself during the few remaining years of the exercise of my art against constantly possible relapses into already conquered errors. In order to make pure music it is necessary to think in pure tones. It is *de facto* the practically insuppressible conventional pianoforte-lie to which nearly all corruptions of hearing may be traced."

With these credentials the inventor has brought a sample of his instrument for examination in England, and I may proceed to give some idea of what it is like.

The great object to be aimed at is facility of performance. It is in this respect that most of the former instruments have failed; the multitude of notes has generally required a new kind of clavier, or the manner of manipulating them has been so complicated and difficult as to require a special learning attended with much trouble. The present instrument is a harmonium of five octaves, having a key-board modelled precisely on the usual pattern and size. Dr. Tanaka has greatly simplified the problem by adopting the transposing system, often adopted with pianofortes. Whatever key the music is in, it is played in the simplest of all keys, the key of C, and by means of a bodily shifting of the key-board to the right or left, it is set so as to act in the key required. It is, in fact, the principle used in the horn tribe; the horn or trumpet player reads and plays his music in the key of C, and the transposition of this to the key required is previously arranged as a part of the mechanism of the instrument; or, rather, as the author puts it, the music may be read and played on the tonic sol-fa system, and he might have adopted its symbols if he had not feared it would be too startling a change.

The points in which the new key-board differs from the ordinary one are, that the black keys are divided, some into two and some into three parts, and one additional shorter and narrower black key is introduced between the E and F white keys. This arrangement gives twenty notes, which suffice for modulating into a reasonable number of keys with sharp signatures.

To provide for modulations into keys with flat signatures, since these and the sharp modulations are not both wanted at the same time, six of the notes can be instantaneously changed for the purpose, at any time, in a manner hereafter explained.

The whole of the keys are well under the hand, and, if the performer knows which note he ought to use, he can take it in any usual chord without difficulty.

Fig. 1 represents one octave of the key-board as arranged for the key of C, with provision for modulating into keys with sharps.

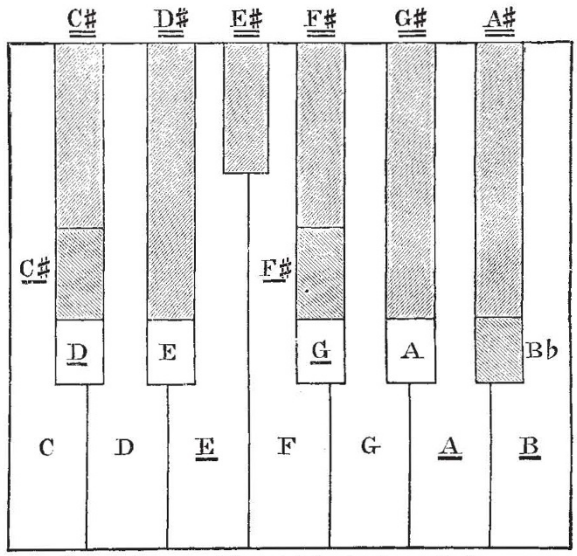

FIG. 1.—As arranged for modulation into keys with sharps.

In order to explain the exact intonation or musical position of the notes, the author adopts a notation already pretty well known—namely, when the letter indicating a note has no line above or below it, it is intended to correspond with what may be called the "Pythagorean" position of that note, which is given by a succession of fifths upwards from C as a base. If the letter has a stroke below it—thus, E—it is a comma below that position; and if the stroke is above—thus, E—it is a comma above that position. Two strokes below—thus, C♯—indicate two commas below.

Now, in the first place it will be seen that the ordinary seven white keys indicate the seven ordinary notes of the major scale of C, according to the intonation usually understood, *i.e.* the major triads on the tonic, dominant, and subdominant, being perfectly in tune.

But as, for certain harmonies, variations of some of these notes are required, there are four alternative small white notes, D, E, G, and A, placed at the near extremity of four of the black ones. For example, the note D is the one required to make the true minor third  , or the true fifth  .

The position of the keys for the sharp notes, and also their intonations, will be seen in the figure. F♯ and C♯ each require alternative values, a comma distant from each other, and these are obtained by dividing the black keys in the manner formerly practised with some organs in this country.

It will be seen that there are in all twenty effective finger keys, each sounding a separate note.

When it is requisite to modulate into keys with flats, the above arrangement will not answer; and the necessary change is made by a lever placed conveniently for being worked by the knee of the player, like the swell of a harmonium.

When this is pushed over, the six hindmost black keys are altered from sharps to flats, as shown in Fig. 2. C♯ and F♯ still remain, and an alternative B♭ and an alternative F are added. This change gives six new notes, so that the total number of sounds used in the octave, for the key of C with its modulations, is twenty-six.

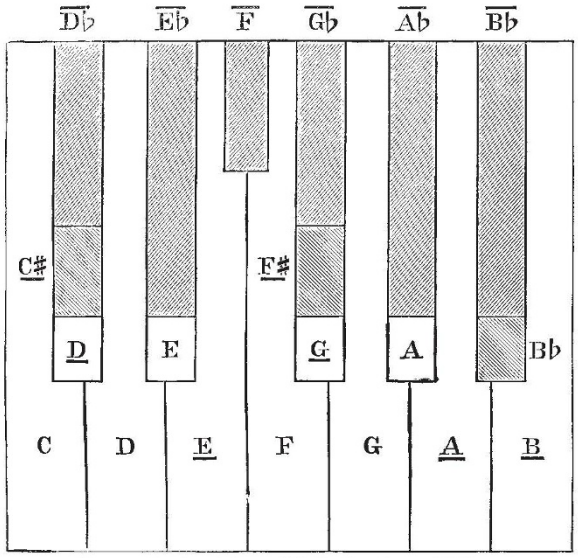

FIG. 2.—As altered for modulation into keys with flats.

As a further indication of the exact musical positions of these twenty-six notes, their ratios of vibration with the keynote C, may also be given. And the logarithms of these (here limited, for simplicity, to three places) will represent approximately the height of each note above C. In this scale, an octave is represented by 301, a mean semitone by 25, and a comma by 5.

Table of the Positions of the various Notes used for the Key of C.

	Ratio.	Logarithm.		Ratio.	Logarithm.
C =	1	... 0			
D =	$\frac{9}{8}$	... 51	D =	$\frac{10}{9}$	... 46
E =	$\frac{5}{4}$	... 97	E =	$\frac{81}{64}$	... 102
F =	$\frac{4}{3}$	... 125	F =	$\frac{27}{20}$	... 130
G =	$\frac{3}{2}$	... 176	G =	$\frac{40}{27}$	... 171
A =	$\frac{5}{3}$	... 222	A =	$\frac{27}{16}$	... 227
B =	$\frac{15}{8}$	... 273			
F♯ =	$\frac{45}{32}$	... 148	F♯ =	$\frac{25}{18}$	... 143
C♯ =	$\frac{135}{128}$	... 23	C♯ =	$\frac{25}{24}$	... 18
G♯ =	$\frac{25}{16}$	... 194			
D♯ =	$\frac{75}{64}$	... 69			
A♯ =	$\frac{225}{128}$	... 245			
E♯ =	$\frac{675}{512}$	... 120			

	Ratio.	Logarithm.		Ratio.	Logarithm.
B♭ =	$\frac{9}{5}$	... 255	B♭ =	$\frac{16}{9}$	.. 250
E♭ =	$\frac{6}{5}$	... 79			
A♭ =	$\frac{8}{5}$	... 204			
D♭ =	$\frac{16}{15}$	.. 28			
G♭ =	$\frac{64}{45}$	.. 153			

This information will enable any student of musical theory to judge of the capability of the instrument to play modern music with just intonation. The great object is, of course, to play the consonant triads, major and minor, in strict tune, and it will be found that the instrument, as above arranged, will play the following

Major Triads on—
C, D, E, F, G, A, B,
F♯, B♭, E♭, A♭, D♭, G♭,

Minor Triads on—
C, D, E, F, G, A, B,
F♯, C♯, G♯, D♯, A♯, B♭,

and some of each in duplicate with a comma variation. These would certainly seem sufficient for all ordinary music in C major or A minor.

By means of the transposing movement, the key-board can be set upon either of the eleven other keys, for which a similar modulating power is obtained, except in some very remote cases. In order, however, to effect this, ten additional notes are used, making thirty-six in all. But the adaptation of them is entirely automatic, and the mechanism for this purpose constitutes one of the chief novelties of the invention.

This is the provision for the purpose by the manufacturer. Now, let us see what the *performer* has to do.

In the first place, whatever key the original composition is in, it must be played in the key of C. In these days of strict examinations by the College of Organists, it is not uncommon to find players who can transpose at first sight from any key into any other. For players who cannot do this the piece will have to be re-copied, but this is nothing in comparison with the great gain in simplicity of the key-board.

Secondly, the performer has not only to play the music in the ordinary way, but he has another problem before him—namely, where certain notes are in duplicate, he has to decide which of the two to use. Now this, although by no means a difficult matter, requires some knowledge of the theory of music, in a sense beyond what is ordinarily taught. To explain it would lead us into more technical detail than would be proper here; but Dr. Tanaka, in compassion for those unfortunates with whom music "has not been made an affair of vibrations," has shown that the printed music can have certain very simple symbols prefixed to the notes, which will easily guide the purely "practical" player what to do.

In this way any competent organist, though he may never have heard of the system before, may, after a few minutes' explanation, and a quarter of an hour's practice, play any piece of music correctly in the true musical intonation, a result which, I believe, has never been attained by any former instrument, and which says much for the ingenuity of the whole contrivance.

It is recorded that the Emperor of Germany expressed a wish to see the experiment tried on a large organ, and the inventor is now engaged in constructing one with eight stops, and a simplified enharmonic pedal-clavier, for the Prussian Goverment.

WILLIAM POLE.