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STROBOSCOPIC TUNING APPARATUS

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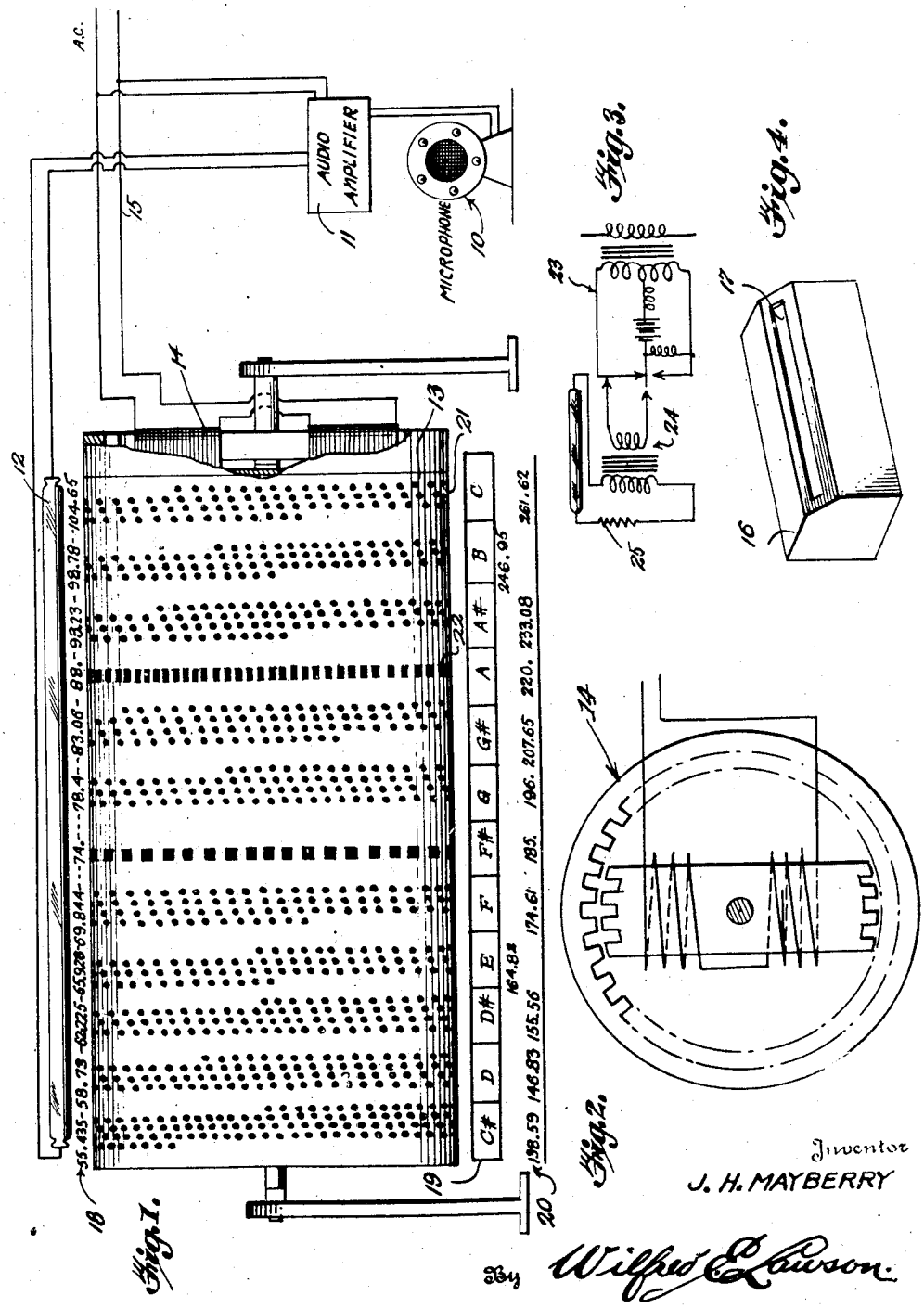


Fig. 1.

Fig. 3.

Fig. 4.

Fig. 2.

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STROBOSCOPIC TUNING APPARATUS

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2 Claims. (Cl. 88—14)

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This invention relates to improvements in stroboscopic tuning apparatus and pertains particularly to apparatus of this character designed for visual tuning.

In some present known types of stroboscopes use is made of gears for driving or turning the rotating members. However it is not possible, by the use of gears, to drive the usual discs which are employed each for a particular tone, to obtain speed ratios between the discs of the same value as the ratios between the numbers of vibrations in the successive chromatic notes. As is correctly stated in prior Patent No. 2,286,030 an exact ratio cannot be secured by the use of gears and various means have been devised for compensating this deficiency but with all such means there still remains, because of the use of the gears as stated in the patent referred to, a margin of error.

The present invention has for a primary object the provision of a stroboscopic tuning apparatus designed primarily for tuning musical instruments, although it is not limited to such use, wherein the use of gears is entirely avoided and whereby the ratios between the rotating visual elements or indicators are absolutely the same as the ratios between the numbers of vibrations in the successive chromatic tones.

Another object of the invention is to provide an improved stroboscopic apparatus which makes possible the measuring of frequencies which come out in fractions.

Still another object of the invention is to provide an improved stroboscopic tuning apparatus making use of a single rotating member which carries a plurality of groups of symbols representing tone frequency or pitch values each having a direct ratio to a known pitch frequency, with a synchronous motor operating means for turning the member at a known speed whereby the correctness of tone of any one of the number of tones of known pitch value covered by such groups will be shown upon causing the flashing frequency of an illuminating lamp to be varied over the range of the frequencies of the tones represented by the said groups.

Still another object of the invention is to provide an improved stroboscopic apparatus of the character above set forth in which the series of values carried by the rotating member is graduated to cover the pitch of tones over an entire octave and in which the member is rotated at synchronous speed for coaction with a flasher controlled by electric current vibrations having frequencies corresponding to sound vibrations.

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Another object of the invention is to provide a stroboscopic apparatus of the character above stated, by means of which a change in speed will change the pitch of the entire octave and in which, also, it is possible to tune several octaves without changing the speed of rotation of the turning member or by which the pitch may be raised a fraction of a tone or to a sufficient degree to place the entire pattern of the tone value indicating symbols on the rotating member, in a different octave by changing the synchronous speed of the rotating member.

Many other advantages and objects of the present invention will become apparent as the description of the same proceeds, and the invention will be best understood from a consideration of the following detailed description taken in connection with the accompanying drawing forming a part of the specification, it being understood that minor changes and modifications may be made in the invention so long as such changes and modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

In the drawing:

Figure 1 is a diagrammatic illustration of a stroboscopic apparatus constructed in accordance with the present invention.

Figure 2 illustrates conventionally a form of synchronous motor forming a part of the cylinder structure.

Figure 3 is a diagram illustrating the application of the invention to a vibrator.

Figure 4 illustrates a form of casing or housing in which the apparatus may be inclosed for use.

In accordance with the present invention, an illustrative embodiment of which is diagrammatically shown in the accompanying drawing there is provided a sound pick-up instrument in the form of a microphone 10, which is coupled in a conventional manner with an audio amplifying apparatus 11 of any conventional design.

The out-put of the amplifier is fed into a neon or gas discharge tube 12 through an impedance matching transformer. Accordingly as will be readily recognized the apparatus translates sound vibrations into electric current vibrations having corresponding frequency and the glow lamp or tube 12 will be energized by said current vibrations at the same frequencies as those of the sound vibrations picked up by the microphone 10.

The stroboscopic member of the present ap-

paratus is in the form of a cylinder 13 which is horizontally disposed and rotatably supported at its ends, in any suitable manner for rotation about its longitudinal axis. The cylinder forms an integral part of and is turned by a synchronous motor 14 which in the present illustration has 24 pole pairs for the execution of two and a half revolutions per second. The current supply for the synchronous motor is taken from a conventional source through the leads 15, such source also supplying the necessary current to the pickup and amplifying system as illustrated.

While there has been shown and described a synchronous motor turning at two and a half revolutions per second, there may be employed a motor turning at any other synchronous speed such as 3.157 R. P. S., which construction would, of course, require 38 poles instead of 24 as previously stated for the first-mentioned speed.

The cylinder 13 has formed around the surface 12 encircling series of dots, squares or other suitable symbols which make up a black and white pattern corresponding to 12 tones in a chromatic octave, the octave selected for use being that below middle C on a key-board instrument.

While it is not essential to the use of the invention that the cylinder be inclosed in a housing, such housing is, however, illustrated and designated 16, with the slot window 17 through which may be viewed the series of circular lines of symbols carried by the cylinder. The provision of such a housing also makes convenient the placement of the values 18 each above and designating the number of dots or symbols in each of the circular lines or series.

Below the window and in the line with values 18 may be placed the conventional tone symbols 19 of the selected octave with the frequency values thereof as indicated at 20.

The whole tones such, for example, as A–220, will have an even number of dots or symbols in the series around the cylinder to make one complete circle of the cylinder. The tones which are not even and which have fractions, such as C–261.62, are arranged to spiral around the cylinder in such a way as to make at least three complete circles of the cylinder as indicated at 21. The series of dots above referred to as designating the tone A, is designated 22.

The values indicated at 18 above the window give the number of symbols in each circular series forming a fraction of the frequency values for the under-lying indicated tones. When the cylinder is turned by the synchronous motor at the selected speed and the lamp 12 is flashed at the correct frequency of a particular tone, such as A, for example, the flashes of the lamp and the movement of the dots each past one point will be synchronized so that the dots or symbols of the series A will appear to be stationary thereby showing the tone to be at the proper pitch or having a frequency of 220 which is two and a half times 88, the value shown in the value column 18 above the circular series of symbols 22.

In the case of those tones which have fractions such as C–261.62 the spiral will have the number of dots or symbols required to cause 261.62 dots to pass the observation point per second. In the arrangement illustrated in the spiral series 21, the dots are in such number and arrangement that in one revolution of the cylinder 104.65 dots will pass the point of observation and upon turning of the cylinder two and a half

times per second the required number of 261.62 for the tone C will pass the observation point per second as stated. The only difference which will be noted between the pattern of the even number of dots in a circular series and that of the spiral, is the slow side motion which will be observable of the spiral.

As previously stated in the objects of invention, the present apparatus makes possible the measuring of frequencies which come out in fractions. Since in any key-board instrument it is necessary to set a temperament in order to play in many keys without using an inconveniently large number of keys to the octave, the temperament, which it is necessary to set, on these instruments determines the degree of departure from the pure scale in order to accomplish this. This is also the reason why the tones come out in fractions. As previously pointed out the use of gears in a device of the character herein described to obtain a separate pattern for each tone, is not possible since the mathematical ratio available with the use of gears will not give the required separation.

The separation of the tones in any key-board instrument graduates at the ratio of the twelfth root of two, or in other words a ratio of 1.05946. This separation cannot be obtained by the use of gears in the rotation of patterns as set forth above but it is possible for the rotation of the patterns by the means herein disclosed.

In further illustration of how the desired separation or ratio between the patterns is obtained to correspond to the separation between the frequencies of the tones of the chromatic scale, the illustration in Figure 1 makes clear how, on a basis of 2.5 revolutions per second for the cylinder the frequencies noted are available, which frequencies cover the octave below C, universal pitch of A–440. If the cylinder is revolved at two times this speed, or five revolutions per second, the next higher octave will be available, beginning with C sharp–277.18.

The observed pattern remains in tune within itself and the tones or frequencies graduate at the ratio of 1.05946, or the twelfth root of two.

Any other pitch may be had by turning the pattern at a predetermined speed since the frequencies are linear and they will bear the same ratio to each other.

Describing more fully the stroboscopic action of the present invention, the musical tone is first picked up by the microphone 10 and amplified by the audio amplifier unit 11. The output of the amplifier unit is fed into the tube 12, which may be a neon or any suitable tube, thus illuminating the revolving pattern. Since the eye cannot separate pulsations of light above 26 per second, the light will appear to be steady.

The pattern is being turned at a definite rate of speed with the black and white lines passing the point of observation corresponding to the tones of the chromatic tempered musical scale. For example, the tone of A–220 C. P. S. is sounded and at the same time the A zone of the revolving pattern is observed. There are 220 black lines per second passing the point of observation. If the tone is in tune, a black line will be at the same place every time the light flashes, or every $\frac{1}{220}$ of a second, therefore, the zone will appear stationary.

If, for example, the tone was 219 C. P. S., the black lines or dots would continue to pass at 220 lines per second and the light would be flashing

only 219 times per second. Thus the line, or dot, will appear at a slightly different place each time and will move the interval of one line per second in the direction of the pattern rotation or movement. If, however, the tone was 221 C. P. S., the line or dot would appear to recede, or move back, from the direction of pattern rotation.

In the case of fractional tones, such, for example, as the tone of D–293.67, the interval between the lines or dots will allow one line or dot to pass the point of observation every 1/293.67 of a second. Since in any stroboscopic apparatus resonance is denoted by the apparent stability of the zone, the interval between all lines or dots on the component or zone of the pattern must be the same, just as the time interval between flashes of light must be the same for the particular frequency under observation. Spiral components or zones were designed for the tones of fractional frequency with the correct interval between lines or dots corresponding to the tone of fractional frequency. In observing the pattern it is not necessary to follow one turn of the spiral, but to observe all of the zone as a whole since all of the lines or dots of the zone are equally spaced. Resonance is denoted in the usual manner, that is, by the apparent stability of the zone.

The 12 semitones or half-tones of the octave of the chromatic tempered scale are therefore designed for the ratio of the 12th root of 2 or a graduation of 1.05946 per semitone, the single pattern with 12 zones or components of the pattern corresponding to the frequency of the tones of the standard octave when tempered.

The pitch could be changed, however, by changing the speed of rotation.

Figure 3 illustrates a method of tuning a vibrator with the use of an ignition coil **24**, the vibrator being designated **23**. The neon tube is connected across the secondary of the ignition coil while the primary of the coil is connected across the vibrator points for excitation. A resistance **25** of twenty thousand ohms is placed in series with the secondary of the coil and the neon or gas discharge tube, to avoid over-load.

The present device is selective and discriminates between noise and a musical tone. It is possible for one to tell at a glance whether a tone is sharp or flat. If the tone is in tune or in resonance the pattern will remain stationary but if it is sharp the dots will move upward, and if it is flat the dots will move downward. When the tone is adjusted so that the pattern remains stationary, the tone will be in resonance or in unison with the revolving pattern.

The technique of the instrument is mechanically perfect since the pattern remains fixed and the established ratio of vibration for each tone is fixed. Operation of the device at a higher or lower speed will change the pitch of the entire octave but at the same time all tones within the rotating pattern bear a linear relationship between each other. If the speed is doubled, for instance, the octave higher can be tuned as previously pointed out.

It is also possible to tune several octaves without changing the speed, however the patterns will appear differently. For example the octave above will make the dots appear to be twice in number and there will also be a shift in the position. The octave below will look much like the fundamental octave but not so sharp. An instrument can be tuned to any pitch by changing the number of revolutions of the cylinder per second. A synchronous speed is best selected in practice,

to thus eliminate the use of governors or various means of imparting the desired speed to the cylinder.

The pitch may be raised a fraction of a tone or it may be raised enough to place the entire pattern in a different octave. For example, turning the cylinder at 3.157 revolutions per second which is a synchronous speed, will give the octave F to E around middle C in the pitch of A–441.1. It will be noted that the even number of dots previously used for F sharp, as illustrated in Figure 1 now becomes A sharp–233.70 which is a fraction. This is an example of the flexibility of the apparatus. Any desired pitch can be obtained by changing the speed of rotation of the cylinder.

Two tones can also be sounded simultaneously and the respective patterns will be observed on the device at the same time, since the frequencies will be different and the observer may easily note two symbol groups simultaneously, each of which would represent a tone and be illuminated at the tone frequency.

While in the preceding description reference has been made entirely to the tuning of musical instruments it is to be understood that there is no intention of limiting the scope of the invention to such use since it may be used to tune any piece of apparatus producing an audible sound such as mechanical vibrators and automobile horns, or for measuring the speed of rotating objects, calibrating oscillators, and checking tachometers.

I claim:

1. A stroboscopic apparatus, comprising a body supported for rotation, a number of groups of symbols carried by such body, the symbols of each group being disposed around and substantially concentric with the axis of rotation of the body, each group representing a tone of the musical scale, the symbols representing the tones of even frequency being arranged in a circle and the symbols representing tones of fractional frequency being arranged to form a spiral, each of said groups consisting of a whole number of identical symbols, the symbols of each group being equally spaced apart so that the same number of symbols passes a point of observation with each revolution of the body, means for turning the body on said axis at an unvarying number of revolutions per second, which number of revolutions multiplied by the number of symbols passing the point of observation per revolution is the exact frequency of the musical tone represented by each group of symbols, means for translating sound vibrations into electric current vibrations having corresponding frequencies, and a glow lamp arranged to illuminate the body and the groups of symbols and connected with the sound translating means to be energized by the electric current vibrations at the said frequencies.

2. A stroboscopic apparatus, comprising a body supported for rotation, a group of symbols on said body and arranged around and substantially concentric with the axis of rotation of the body, the group consisting of a whole number of identical symbols, said group representing a musical tone of fractional frequency and being arranged in a spiral, the symbols of the group being equally spaced apart so that the same number of symbols passes a point of observation with each revolution of the body, means for turning the body on said axis at an unvarying number of revolutions per second, which number of revolutions multi-

plied by the number of symbols passing the point of observation per revolution is the exact frequency of the musical tone represented by the group, means for translating sound vibrations into electric current vibrations having corresponding frequencies, and a glow lamp arranged to illuminate the body and groups of symbols and connected with the sound translating means to be energized by the electric current vibrations at the said frequencies.

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