Jan. 26, 1965 MINORU IKEDA 3,167,315

MUSICAL INSTRUMENT

Filed Oct. 18, 1961 2 Sheets-Sheet 1

Fig. 1.

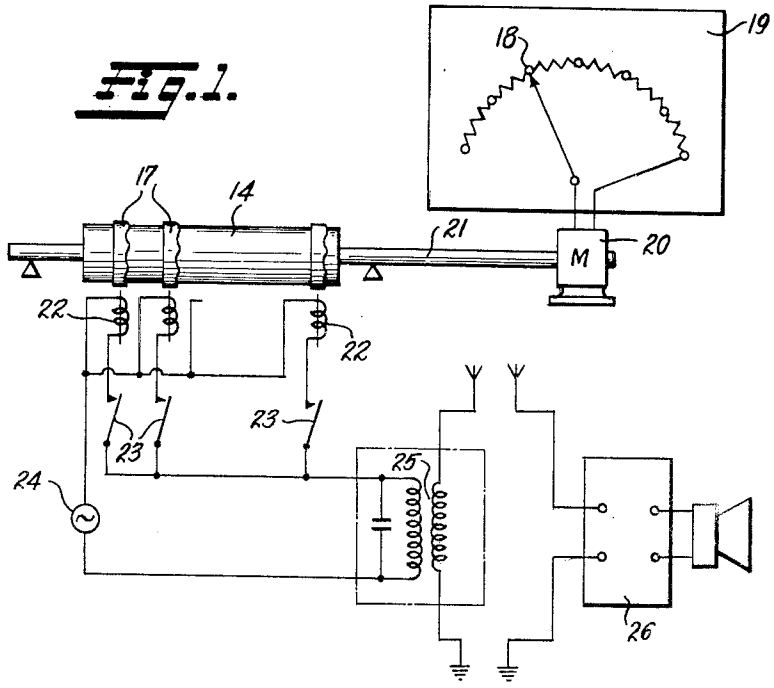
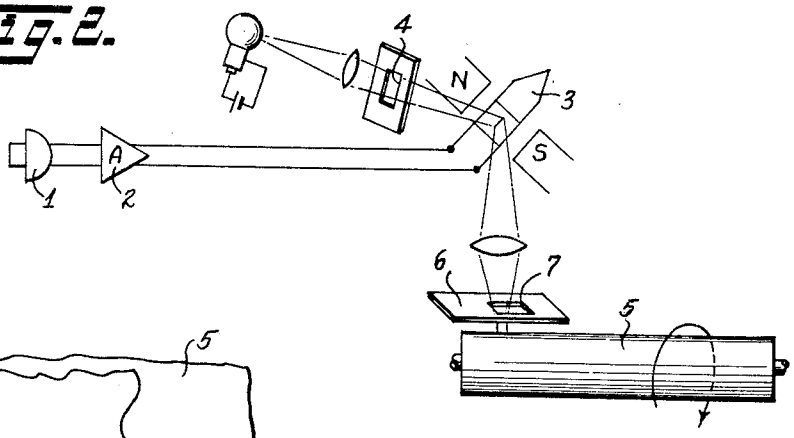


Fig. 2.



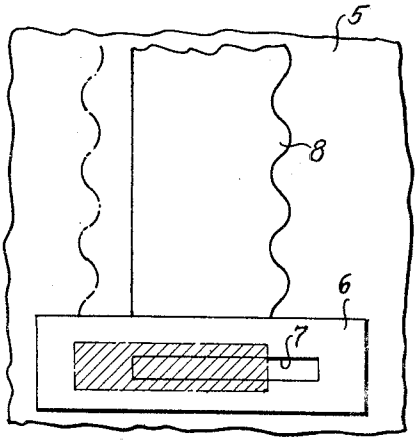


Fig. 3.

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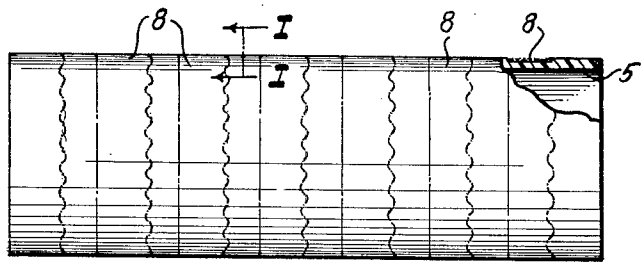

Fig. 4.

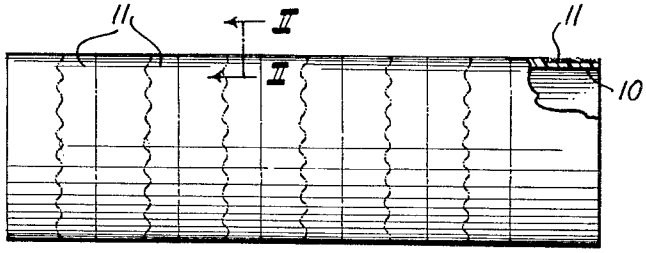

Fig. 5.

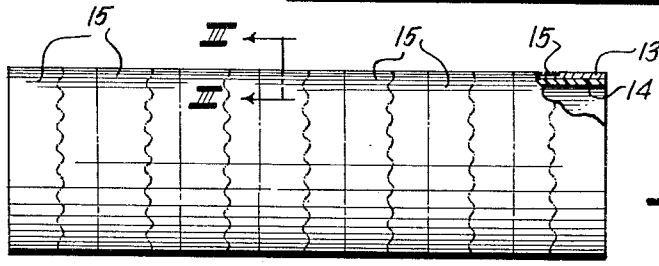

Fig. 6.

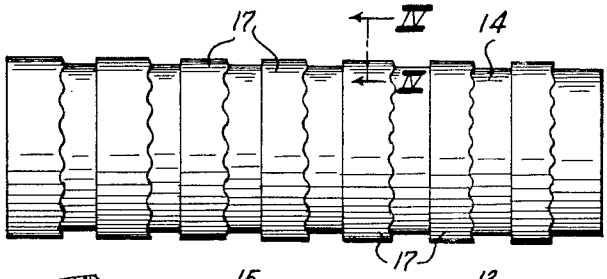

Fig. 7.

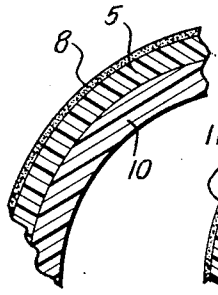

Fig. 8.

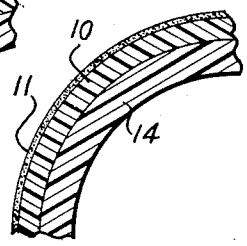

Fig. 9.

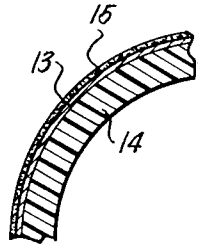

Fig. 10.

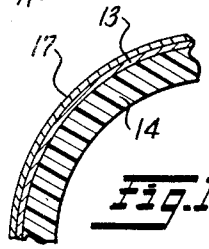

Fig. 11.

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3,167,315

MUSICAL INSTRUMENT

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35/50,539
3 Claims. (Cl. 274—3)

Among the conventional electrical musical instruments, the system of recording the sound optically and reproducing it by means of a photoelectric tube or photoelectric cell has been found too complex in its mechanism. On the other hand, in those electrical musical instruments having magnetic sound-recording bands on a tape or steel strip or steel wire arranged successively around a rotating drum at definite intervals, with a reproducing head placed opposite to each of these bands, residual magnetism is utilized. Therefore, the de-magnetizing action taking place in the reproducing head will steadily dissipate the residual magnetism of recordings. Particularly in a musical performance, when the frequency of use of the keys on the board differs from band to band, the de-magnetizing action also differs from band to band, so that it will be impossible for each key to produce an equal sound volume. Thus these systems were found inadequate for musical instruments. An earlier invention by the present inventor utilized a mechanical means of recording musical sounds, and was accordingly unfit for mass production; moreover, it could not fully develop the advantages of an electrical musical instrument, because no provision was made for transmission and reception. The object of the present invention is to offer a new electrical, musical instrument which permits mass production and is free from the interference of noise due to electric wave radiation.

The present invention consists of a method of manufacturing a musical sound recording tube and of an electrical, musical instrument utilizing a recording tube prepared by the said method.

The details of the invention will be apparent from the following description, when read in connection with the accompanying drawings, wherein:

FIG. 1 is a circuit diagram of the electrical, musical instrument using magnetic recording bands formed by the optical method according to the present invention.

FIG. 2 shows the state of a musical tone with a certain frequency of vibration being registered on a light-sensitive film around the circumference of a cylinder.

FIG. 3 illustrates the relationship between the beam of light that does not pass through the slit and the beam of light that is projected on the light-sensitive film through the slit.

FIG. 4. is a partially cut-away front view of the cylindrical original.

FIG. 5 is a partially cut-away front view of the cylindrical negative.

FIG. 6 is a partially cut-away front view of the cylindrical positive.

FIG. 7 is a front view of the musical sound recording tube according to the present invention.

FIGS. 8, 9, 10 and 11 are respectively enlarged local sections of FIGS. 4 at I—I, 5 at II—II, 6 at III—III and 7 at IV—IV.

The musical sound recording tube according to this invention is produced as follows.

Musical sounds of pianos, violins, wind instruments or human voices with definite frequencies are transmitted through the microphone **1** to the electromagnetic oscillograph **3** by the recording amplifier **2**. This oscillograph is of the type comprising a movable mirror. At the same time the beam of light with a specified width is projected

through the first slit **4** onto the mirror of said oscillograph **3**. Then, a horizontally oscillating beam of light with a specified width will be obtained as a reflection.

If this reflection is projected, say, with a left inclination, through the second slit **7** onto transparent plastic cylinder **5** which is entirely coated with a light-sensitive material like cold enamel for photo-plate preparation, the left half of this oscillating reflection with the above-mentioned width will be shielded by the slit plate **6** and only its right half will be projected onto the said cylinder **5** through the slit **7** of said plate **6**. Therefore, when the said cylinder **5** is rotated at a constant speed, a wave-form of required frequency will emerge on the right border of the exposed area **8** on the light-sensitive film on the surface of said cylinder, and a straight edge will result on the left border. If the slit **7** is blocked or the light source shut off at the end of one rotation of the said cylinder **5**, the band of exposed area **8** will become continuous. Thereafter, this procedure is repeated at necessary intervals on the said cylinder **5** in the order of frequencies, the ratios of which to the main tone in one octave constitute a musical scale, for example in the order of 8 tones, i.e., do, re, mi, fa, sol, la, si, do. The transparent cylinder **5**, on which eight endless bands of exposed area **8** have been created in the above-mentioned order of frequencies, is developed with these bands of exposed area **8** stabilized against the light. This cylinder is adopted as the original plate. In this plate **5** is inserted a plastic-made transparent cylinder **10** which carries the same light-sensitive film as the one on the said cylinder **5**. Light is projected on the outer surfaces of the cylinders **5**, **10** which are rotated at the same speed, and as a result a series of bands **11**, complementary to bands **8**, is printed on the light-sensitive film of said cylinder **10**. Then the transparent cylinder **10**, with its bands of exposed area **11** which are diametrically opposite in pattern to the bands **8**, is developed. Thus a cylindrical negative with its endless bands of exposed area stabilized against the light is obtained.

Next, into the said negative is inserted a plastic cylinder **14** with the same light-sensitive film as the above formed on the copper layer **13** of its circumferential surface. (See FIG. 6.) Again, light is projected on the outer surfaces of the cylinders **10**, **14** which are rotating at the same speed and as a result bands **15** complementary to those on the cylindrical negative **10** but identical to those on **5**, are printed on the light-sensitive film. Through developing and etching operations, the endless bands of exposed area **15** on the light-sensitive film are rendered stable against the light and chemicals. This produces a cylindrical positive with its endless bands of exposed area etched on the copper layer **13** beneath it. Following this, the light-sensitive film is wiped off from the bands of exposed area **15**, leaving a wide portion corresponding to the right half of the wave-form on the surface of the cylinder **14**. The bared copper layer portion **13** is then plated with iron. Thus, we get a musical sound recording tube with eight endless bands of iron **17** arranged at certain intervals in the order of eight sounds of do, re, mi, fa, sol, la, si, do, having frequencies of vibration whose ratios to the main tone in an octave constitute a musical scale.

Any conventional photographic and etching solutions may be utilized. For example an aqueous solution of ferric chloride may be used for the etching. If an emulsion of silver halide is adopted as the light-sensitive agent, a fixing operation should be added to the above operation of developing.

By this method, musical sounds, such as sounds of string instruments, brass and wind instruments, percussion instruments, and human voices, which possess frequencies whose ratios to the main tone in an octave con-

stitute a musical scale, can be registered on endless steel bands **17** having a desired amplitude but without any beginning or end, arranged at certain intervals in the order of do, re, mi, fa, sol, la, si, do on a musical sound recording tube, with precision and rapidity, using a single cylindrical original **5**.

An electrical musical instrument according to the present invention will now be described.

The constant-speed motor **20** having a speed controller **19** with a scale calibrated according to musical "keys" rotates the revolving shaft **21**, on which the above-mentioned musical sound recording tube is centrally fitted. Reproducing heads **22** are provided opposite each of the endless steel bands **17** on the said recording tube. Electrical switches **23**, controlled by the keys on a keyboard (not shown) are connected in parallel in the circuit containing the high-frequency electrical source **24** and output containing the high-frequency electrical source **24** the output stage **25**. These switches are respectively connected in series to the reproducing heads **22**; and the receiving set **26** comprises a speaker and is coupled to the said output stage **25** to complete the musical sound reproducing unit.

In the electrical musical instrument of this invention the high-frequency electrical source **24** produces in the reproducing head **22** an induced voltage proportional to the magnitude of magnetic resistance. Therefore, when the electrical contacts for the keyboard are pushed just like those of any common keyboard instrument while the musical sound recording tube of this invention is being rotated at a constant speed by a motor, there is produced in the reproducing head **22** corresponding to the particular key depressed an induced voltage proportional to the magnetic resistance of the corresponding endless steel band **17**. The induced voltage modulates the high frequency. The modulated wave is demodulated by conventional demodulating means (not shown), so that there is no necessity of considering a hysteresis. Thus, not only can the musical sound be reproduced without any distortion, but also rectangular waves can also be faithfully reproduced. Moreover, in the instrument according to this invention, all of the switches are biased toward their open positions and the circuit of the high-frequency electric source will never be closed unless at least one of the electric contacts for a keyboard is closed.

Since no electric wave can be radiated unless the circuit is closed, there is no fear of common noise interference and the noise in time of reproduction of musical sounds is so weak as compared with the latter that it will be drowned thereby and may not be heard as such.

Thus, the present invention gives an ideal pure orthodox tune electrical musical instrument which is free from any noise due to electric wave radiation; has no defects in the construction of the musical sound recording unit, and accordingly no fear of noise being generated by the said unit; is well-balanced in the sound volume regardless of any difference in the frequency of use; and permits transition between and transposition of keys.

What is claimed is:

1. The method of producing a cylinder suitable for use in a musical device which comprises the steps of reflecting a beam of light onto a rotating cylinder having a photosensitive surface, by means of an oscillograph comprising a movable mirror, directing said light beam through a slit which cuts off one edge of said beam before it reaches said cylinder, regulating the movements of said mirror by supplying electrical current having a specific frequency to said oscillograph, so as to produce on said photosensitive surface a plurality of axially spaced exposed bands having wavy edges, with the distance between successive undulations of each band having the same proportional relationship to the distance between the successive undulations on each of the other bands as the frequency of one note of a musical scale bears to that of the other notes, developing said photosensitive cylinder surface, and making therefrom a cylinder having corresponding bands containing magnetic metal.

2. The method claimed in claim 1 comprising the steps of making from said first-mentioned cylinder a second cylinder carrying bands having wavy edges complementary to those of the first mentioned cylinder, plating on a third cylinder having a non-magnetic surface bands comprising a magnetic metal and bands having edges identical to those of said first mentioned cylinder.

3. The method of producing a cylinder suitable for use in a musical device which comprises the steps of reflecting a beam of light onto an annular portion of the peripheral surface of a rotating cylinder having a photosensitive peripheral surface, varying at a predetermined frequency the effective width of said beam as it falls on said surface to form thereon an exposed band of regularly varying width, projecting light beams in like manner against other spaced annular portions of the periphery of said cyinder to form similar exposed bands axially spaced from each other along the cylinder, the frequencies at which the effective width of said light beams is varied bearing the same proportions to each other as the frequencies of the notes of a musical scale, and forming on a non-magnetic cylindrical surface bands comprising magnetic metal having the configuration of said exposed bands.

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