United States Patent

[11] **3,631,756**

[72] Inventor **Robert C. Mackworth-Young**
Garden House, Windsor Castle, Berkshire, England

[21] Appl. No. **29,849**
[22] Filed **Apr. 20, 1970**
[45] Patented **Jan. 4, 1972**
[32] Priority **Apr. 22, 1969**
[33] **Great Britain**
[31] **20,574/69**

[54] **APPARATUS AND METHOD FOR TUNING MUSICAL INSTRUMENTS**
9 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **84/454,** 84/457, 84/DIG. 18
[51] **Int. Cl.** **G10g 7/02**
[50] **Field of Search** ..... 84/1.01, 1.04–1.06, DIG. 18, 454–460; 331/156; 310/15, 25, 26; 324/78 Z, 79

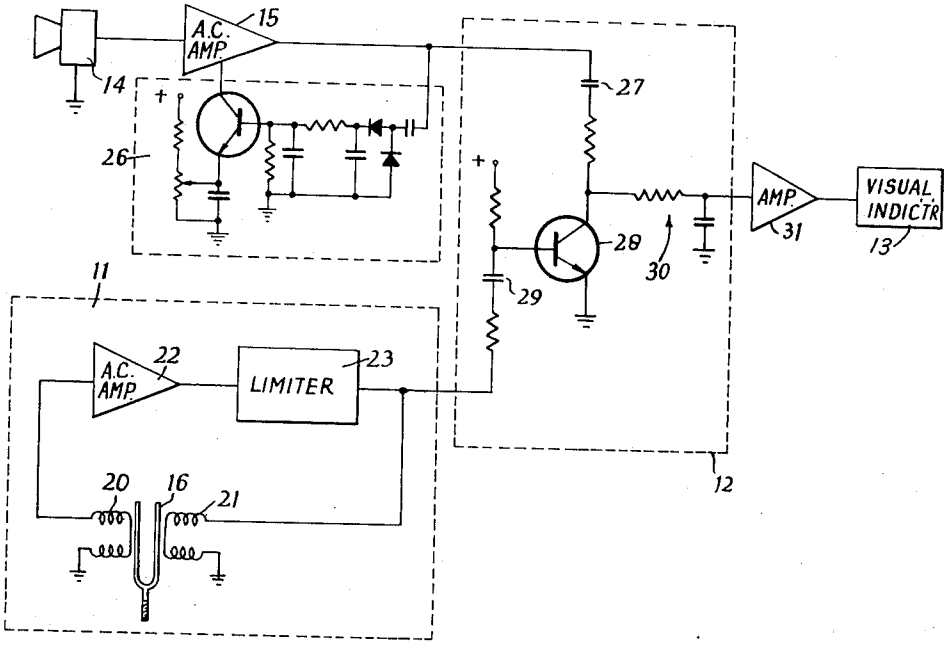
[56] **References Cited**

UNITED STATES PATENTS

2,300,271	10/1942	Whitaker	331/156
2,779,920	1/1957	Petroff	84/454 X
3,382,459	5/1968	Asten	331/156
1,516,947	11/1924	Beindorf	84/454
3,204,513	9/1965	Balamuth	84/454 X
2,542,540	2/1951	Kunz	84/454 X
3,183,761	5/1965	Van Ooyen	84/DIG. 18

Primary Examiner—Lewis H Myers
Assistant Examiner—Stanley J. Witkowski
Attorney—Woodhams, Blanchard and Flynn

ABSTRACT: An apparatus for tuning a musical instrument comprising a generator of electric oscillations of reference frequency including an array of tuning forks which can be brought, in succession, into register with a driving coil for maintaining the adjacent tuning fork in oscillation. A pickup coil provides a signal dependent on vibrations of the said tuning fork. The signal is amplified by an amplifier and fed on the one hand to the driving coil and on the other hand to a frequency comparator with a "magic eye." A microphone, for picking up oscillations from a vibratory element of the musical instrument to be tuned, is connected through an amplifier to the frequency comparator.



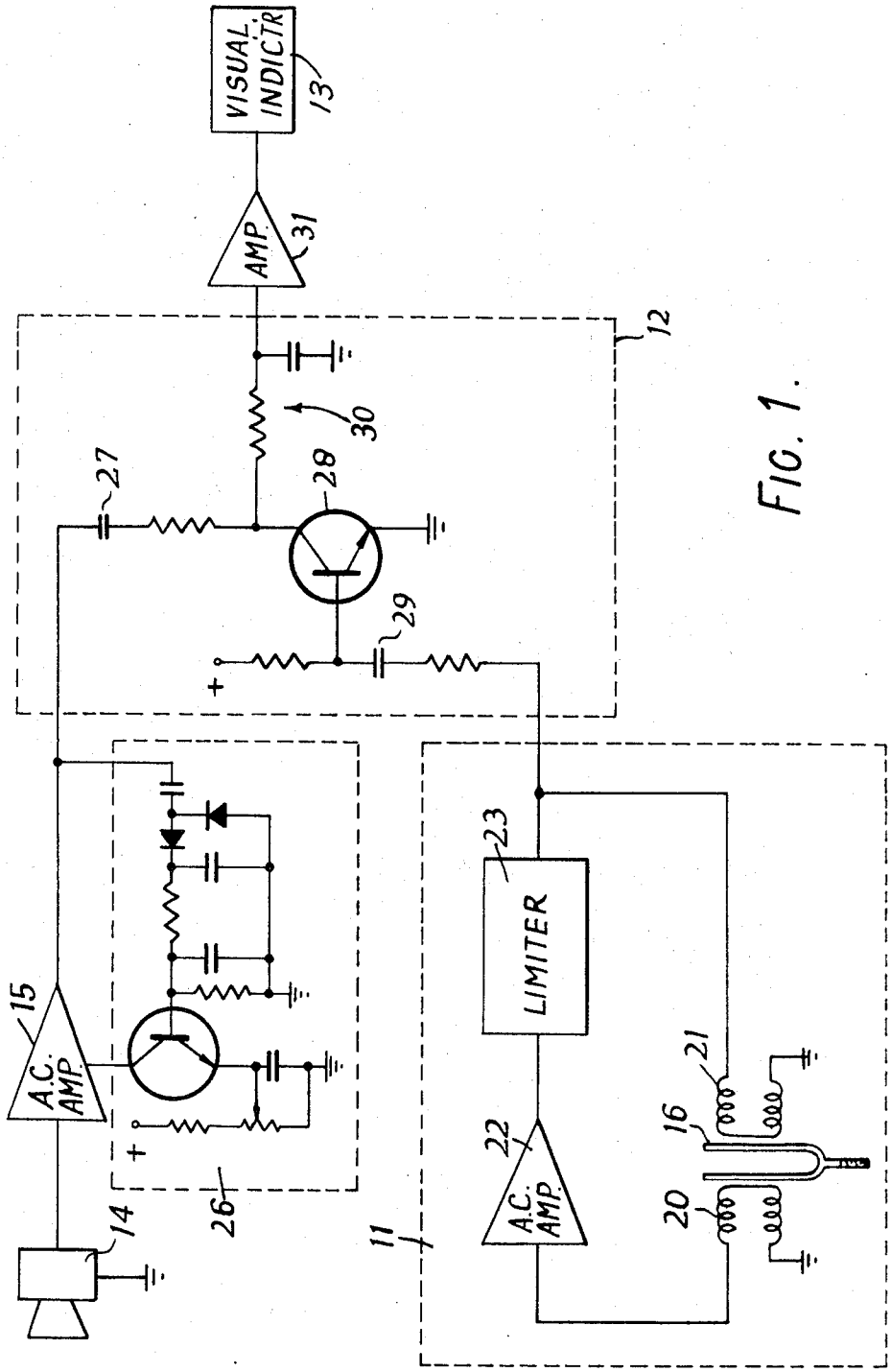


FIG. 1.

INVENTOR
ROBERT CHRISTOPHER MACKWORTH-YOUNG
BY
Woodhams, Blanchard & Flynn
ATTORNEYS

FIG. 2

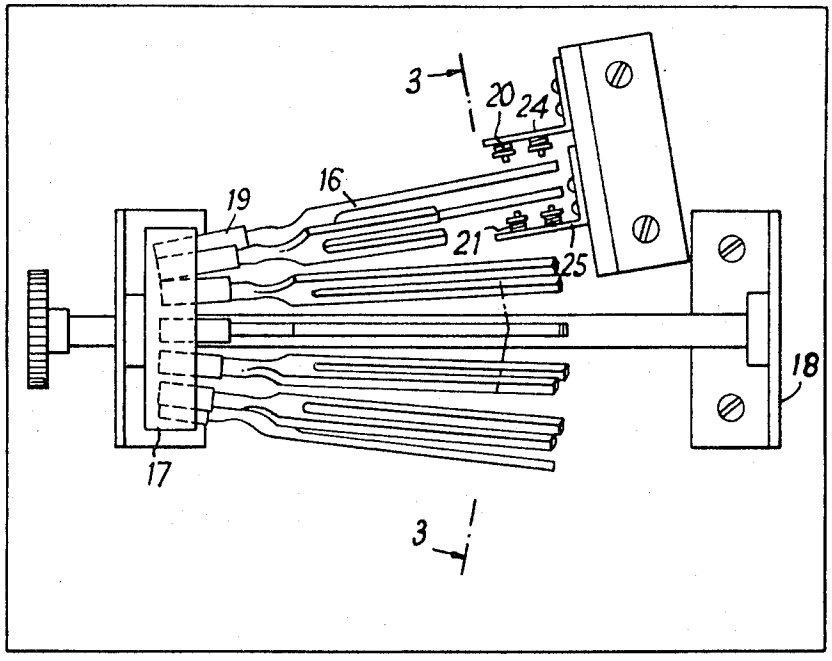
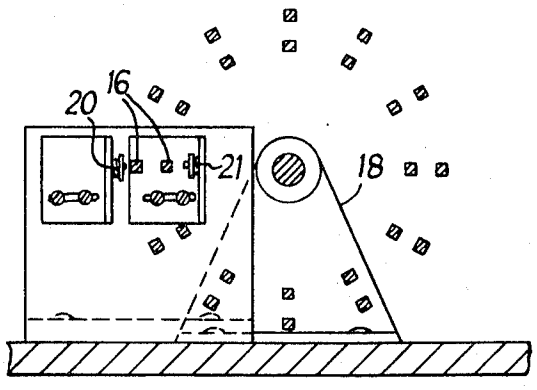


FIG. 3



INVENTOR
ROBERT CHRISTOPHER MACKWORTH-YOUNG
BY
Woodhams, Blanchard & Flynn
ATTORNEYS

APPARATUS AND METHOD FOR TUNING MUSICAL INSTRUMENTS

The present invention relates to apparatus and a method of tuning musical instruments, particularly, but not exclusively, keyboard, stringed instruments.

According to the present invention there is provided a method of tuning a vibratory element of a musical instrument intended to provide a note of given frequency, comprising the steps of generating a first, reference, electric oscillation of the given frequency and applying it to a frequency comparator having an associated visual indicator, generating a sound, electric oscillation from the vibratory element by means of a pickup device located adjacent the vibratory element, applying the second oscillation to the frequency comparator, and varying the tuning of the vibratory element until the indicator indicates zero frequency difference.

The invention also provides apparatus for use in tuning a vibratory element of a musical instrument intended to provide a note of a given frequency f_1, comprising a source of electric oscillations of reference frequency f_1 including a metallic, oscillatory member of resonance frequency f_1 with an associated pickup device arranged to provide a signal dependent on vibration of the oscillatory member, and an amplifier connected between the pickup device and a driving device associated with the oscillatory member to maintain the oscillatory member in oscillation at the frequency f_1, a connection from the source of reference oscillations to a frequency comparator having an associated visual indicator, and a microphone, for picking up oscillations from the vibratory element to be tuned, connected through an amplifier to the frequency comparator.

Preferably the metallic oscillatory members are arranged in a circular array on a base rotatable about an axis coaxial with the circular array to allow the oscillatory members to be brought, in succession, into register with a driving coil. Tuning forks are preferred for the oscillatory members.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings of which:

FIG. 1 is a circuit diagram of an apparatus for tuning musical instruments;

FIG. 2 is a plan of a tuning-fork assembly of the apparatus of FIG. 1; and

FIG. 3 is a transverse cross section of the tuning-fork assembly of FIG. 2.

Apparatus for use in tuning a musical instrument such as a piano, harpsichord or similar instrument, comprises an electric oscillation generator **11** whereby oscillations at the frequencies of any of the 12 notes of a chromatic scale can be generated individually.

The oscillations generated by the generator are applied to a frequency comparator **12** provided with a visual indicator **13** in the form of what is commonly known as a "magic eye."

A microphone **14** for picking up sound waves from a string (not shown) of the instrument to be tuned, when the appropriate key is struck is connected through an amplifier **15** to the frequency comparator **12**.

In use, the appropriate key is struck and the tuning of its associated string is adjusted until the movement of the two fluorescing sectors of the magic eye **13** towards and away from one another ceases.

Thus by means of the arrangement the tuning of a musical instrument can be greatly simplified and made independent of the skills necessary in detecting beats by the ear and tuning the instrument in accordance with such beats.

Describing the apparatus now in more detail, the generator for generating the reference oscillations makes use of a series of 12 tuning forks **16**.

These are arranged around the periphery of a circular base **17** with the limbs of each fork aligned with a radius. The base is pivotably mounted on a main frame **18** for rotation about its center. Indexing mechanism such as a ball and spring catch (not shown) is also provided whereby the base **17** can be indexed to any one of 12 operating positions in which it is positively located.

The tuning forks have screw-thread shanks which are fitted into aluminum tubes **19** of varying lengths to compensate for the varying lengths of the forks for different notes. The tubes **19** are secured to the base **17**.

On the main frame there are mounted electromagnetic pickup and driving coils **20** and **21** respectively and by rotating the base to an appropriate one of its 12 operating positions any selected tuning fork can be brought into register with the pickup and driving coils. The pickup coil **20** of the apparatus shown in the drawing is located within the circle of tuning forks. In an alternative embodiment the pickup coil takes the form of a throat-microphone which is mounted on the base.

When the selected tuning fork is set into oscillation, currents are generated in the pickup coil **20** at the frequency of the tuning fork and these are applied to an amplifier **22**. The amplifier is connected to an amplitude-limiter **23** whereby the magnitude of the oscillations generated can be controlled. The amplitude limiter can be made asymmetrical to ensure the generation of even-numbered harmonics for tuning octaves, double octaves, etc.

The output of the limiter is connected to the electromagnetic driving coil **21** arranged in register with the tuning fork on the opposite side thereof from the pickup coil. The pickup coil **20** cooperates with one limb of the tuning fork and the driving coil with the other. The pickup and driving coils **20** and **21** are mounted on the main frame by means of brackets **24** and **25**. The brackets are secured to the main frame by screws and the holes through which the screws pass are elongated into slots so that the positions of the coils can be adjusted.

The microphone **14** is connected to the amplifier **15** which is also provided with an amplified delayed automatic gain control **26** to give output of constant amplitude.

The amplifiers in the oscillation generator and the microphone circuit are both connected to the frequency comparator. The frequency comparator **12** comprises a phase-sensitive detector. The output of the amplifier **15** is connected through a capacitor **27** which prevents the passing of DC to an electrode of a suitable electronic valve, here to the collector of an NPN-transistor **28**. The emitter of transistor is connected to ground, its base is connected on the one hand to the limiter **23** through a capacitor **29** and on the other hand to a source of electrical potential which is positive with respect to ground. The collector of the transistor is connected to a smoothing circuit **30** which provides the output of the frequency comparator.

The signal from the limiter **23** appearing on the base of the transistor **28** causes the transistor to conduct during positive-going half cycles of the reference-oscillating signal. When the transistor is conducting a short circuit is provided to ground for the signal from the microphone. Thus, the signal coming from the microphone's amplifier during negative-going half cycles of the reference oscillation passes to the smoothing circuit. On smoothing, the signal for each half cycle is indicative of the phase difference between the microphone signal and the reference signal for that half cycle and therefore the signal from the smoothing circuit varies with a frequency which is the beat frequency of the microphone signal and the reference signal.

The output from the smoothing circuit **30** is applied through an amplifier **31** to the magic eye indicator.

For tuning strings over octaves below that encompassed by the tuning forks harmonic generation in the microphone amplifier has usually been found to be adequate. Unwanted lower frequencies can be eliminated by means of a filter. However, the output applied from the amplifier to the comparator can be multiplied in frequency if desired by switching in a frequency multiplier.

For tuning strings over octaves above that encompassed by the tuning forks it is necessary to switch frequency dividers into the output of the microphone amplifier.

It will be appreciated that the invention can be engineered in other ways. For example, instead of moving the base to bring the tuning forks sequentially into register with the pickup and driving coils, the coils can be moved from fork to fork. Although in the embodiment described the tuning forks are arranged with their free ends further from the pivot axis than their shanks, it will be understood that it is possible to arrange the tuning fork parallel to the pivot axis.

I claim:

1. An apparatus for use in tuning vibratory elements of musical instruments intended to provide notes of given frequencies, comprising:

a base;

an array of oscillatory members mounted on the base, the resonance frequencies of the oscillatory members being the said given frequencies respectively;

a driving device for maintaining a selected one of the oscillatory members in oscillation when in register therewith;

guide means interposed between the base and driving device for allowing relative movement between the base and the driving device bringing the oscillatory members successively into register with the driving device;

a pickup device arranged to provide a reference signal dependent on vibration of the selected oscillatory member;

a first amplifier connected between the pickup and driving devices for amplifying the reference signal;

a frequency comparator with an associated visual indicator, and means coupling the reference signal to the frequency comparator;

a microphone for picking up oscillations from the vibratory element to be tuned;

a further amplifier, the microphone being connected to the further amplifier and the further amplifier being connected to the frequency comparator;

whereby the indicator provides an indication of the deviation of the frequency of the vibratory element to be tuned from the frequency of the one of the oscillatory members in register with the driving device.

2. An apparatus as claimed in claim 1, in which the oscillatory members are arranged in a circular array on the base and the base is rotatable about an axis coaxial with the circular array to allow the oscillatory members to be brought in succession, into register with the driving device.

3. An apparatus as claimed in claim 1, in which the oscillatory members are metallic tuning forks.

4. An apparatus as claimed in claim 1, in which the visual indicator is a "magic eye" and in which the frequency comparator is a phase-sensitive detector.

5. An apparatus as claimed in claim 2, including a main frame and means rotatably mounting said base on said main frame, said driving device and pickup device being fixed on said main frame in spaced relation to each other and at a location spaced from said axis of said base, rotation of said base moving said oscillatory members in a substantially circular orbit having a segment between said driving and pickup devices, said pickup and driving devices being common to all of said oscillatory members, said oscillatory members being alternatively positionable between said pickup and driving devices by rotation of said base.

6. An apparatus as claimed in claim 1, in which said pickup and driving devices comprise pickup and driving coils, respectively, and including amplitude limiting means, said pickup coil, first amplifier, limiting means and driving coil being serially electrically connected in a series circuit loop, an input of said frequency comparator being connected to said loop between said limiter and said driving coil.

7. An apparatus as claimed in claim 1, in which said further amplifier is provided with a delayed automatic gain control.

8. An apparatus as claimed in claim 1 in which said frequency comparator comprises an electronic valve having a controlling electrode to which the reference signal is applied for switching the valve on and off at the frequency of the reference signal, a smoothing circuit, means connecting the output of said further amplifier to said smoothing circuit, means connecting said valve to said smoothing circuit for periodically rendering said smoothing circuit responsive to said output of said further amplifier at a rate corresponding to the switching rate of said valve.

9. An apparatus as claimed in claim 2 including means on each oscillatory member connected to said base and responsive to manual adjustment for altering the resonance frequency of such oscillatory member.

* * * * *