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ELECTRONIC TUNER FOR MUSICAL INSTRUMENTS

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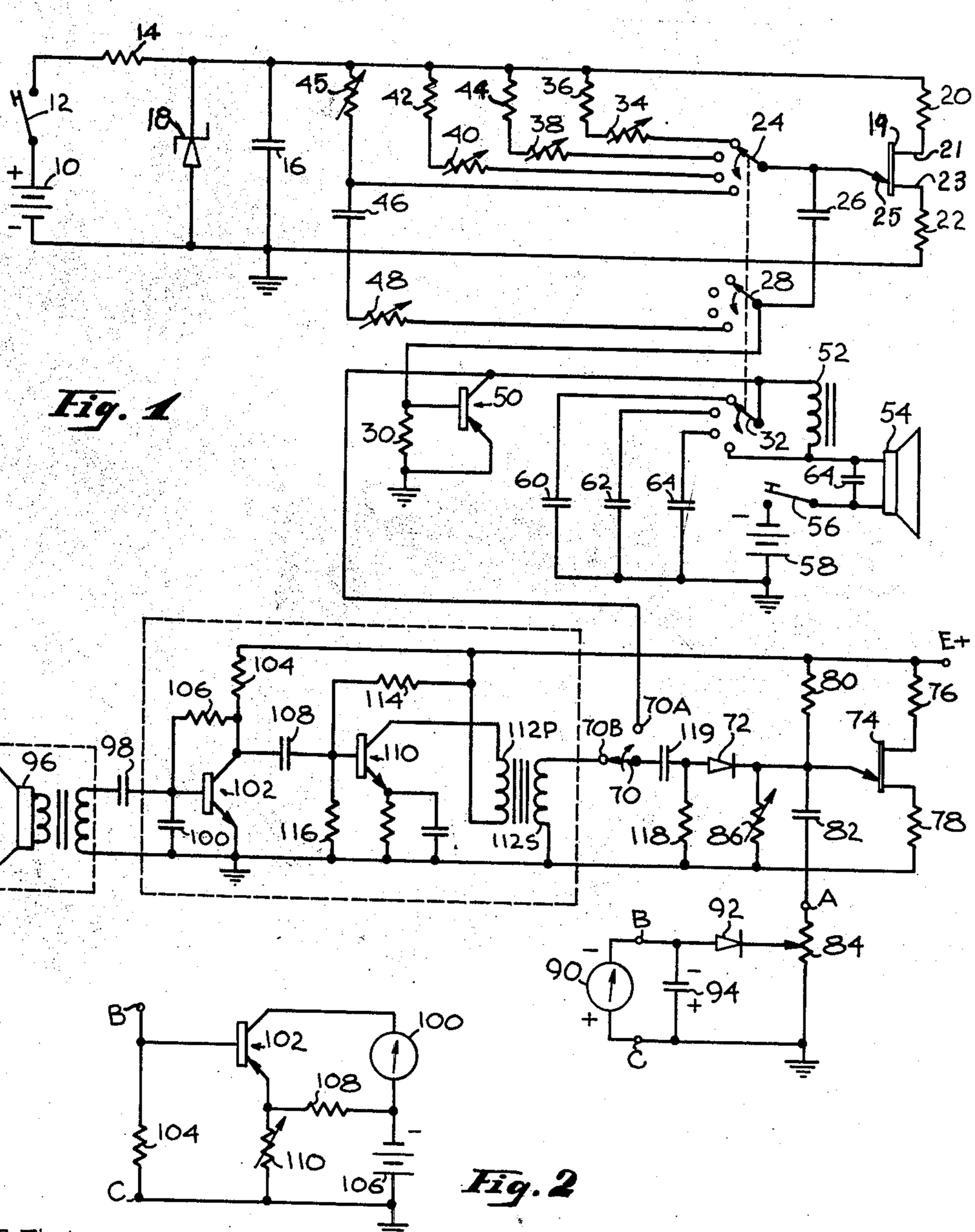

Fig. 1

Fig. 2

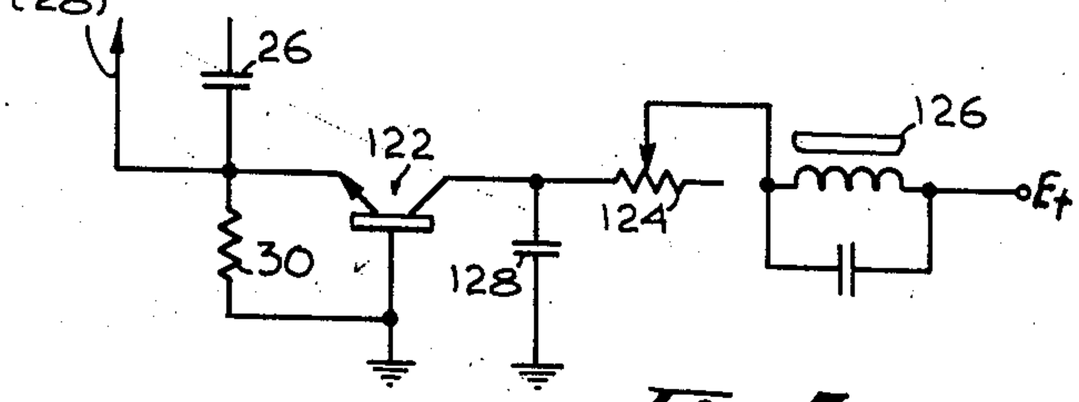

Fig. 3

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ELECTRONIC TUNER FOR MUSICAL INSTRUMENTS

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This invention relates to electronic circuits which may be employed for tuning musical instruments, and more particularly to improvements therein.

The classic method for tuning musical instruments is to use a reference tone which is sought to be matched by the person tuning the musical instrument. The reference tone may be obtained by the note on a piano, by blowing on a pitch pipe, striking a tuning fork, or in the case of orchestras, a wind instdument such as the oboe, may provide the note. One of the problems with respect to striking the note on the piano or with a tuning fork is that these are effectively precussion instruments and if the person tuning the instrument is a bit slow the tone dies away and he must then energize the precussion instruments again. Also, at the time that the piano note or the tuning fork is struck, the person tuning the instrument, if alone, must stop tuning to perform this operation. This is a rather unfortunate and clumsy arrangement.

An object of this invention is the provision of an electronic circuit tuning arrangement which when energized stays energized as long as it is required in order to enable the user to tune his instrument.

Another object of this invention is to provide by electronic amplification a tuning note of sufficient loudness to be heard by all members of a large or small instrumental group.

Still another object of this invention is to provide a simple and inexpensive electronic tuning arrangement which not only provides an accurate note for tuning, but also enables the user to determine visually whether his instrument is properly tuned.

Yet another object of the present invention is to provide an electronic circuit which can furnish the proper notes for enabling the tuning of an instrument and also can serve as a metronome.

These and other objects of the invention may be achieved in an arrangement wherein there is provided a stable, tunable oscillator circuit which can be tuned to energize a loud-speaker with the several required notes for tuning a musical instrument. In addition, the oscillator can be set to operate at low frequencies suitable for providing a beat in the manner of a metronome.

Yet another object of the present invention is to provide oscillator circuitry which not only may be employed to drive a loud-speaker to afford tuning therewith, but may also be employed to drive a visual indicator such as a meter to establish a standard output indication. Associated circuitry is then energized by the instrument being tuned. This circuitry in response to said energization drives the indicator to indicate whether or not the instrument causing such energization is higher or lower in pitch than the standard from which the standard reading of the indicator was established.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is a circuit diagram of an arrangement for enabling tuning of a musical instrument, providing a metronome operation, and for visually determining the accuracy of tuning of a musical instrument.

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FIGURE 2 is a circuit diagram for an alternative arrangement for an output indicator for use with the circuitry shown in FIGURE 1.

FIGURE 3 is a circuit diagram showing an alternative arrangement for obtaining an audio output.

Referring now to FIGURE 1, there may be seen a circuit diagram of an embodiment of this invention. This includes an arrangement whereby an oscillator, whose frequency may be changed, is used to provide an output frequency which is converted into an audio signal. The frequencies to which the oscillator may be switched comprise the frequencies of standard tones suitable for tuning instruments. In addition, a switch position is provided whereby the device acts as a metronome providing timing beats. For those persons having difficulty in determining whether, for example, a stringed instrument is below or above the requisite standard tuning, or even for singers, in order to train them to sing certain notes right on key, means are provided for visually indicating whether they are too low or too high. This difficulty is most apparent in tuning double stringed instruments such as the mandolin, where it is essential that both strings which are used for playing the same note must be tuned exacly alike. Students who are learning to play the instrument, for a considerable time, have dfficulty in tuning the instrument properly.

In FIGURE 1 a source of potential **10** is connected, when required, by means of a key **12**, to the remainder of the circuitry. A constant potential source as well as one which is free from noise is provided by means of a filter section comprising a resistor **14** which is in series with the switch **12** and battery **10**, and a capacitor **16** which is in shunt therewith. A Zener diode **18**, which is connected across the capacitor assisits in maintaining voltage across the capacitor and load constant. As an alternative arrangement for this potential source, a single mercury battery having a constant reference potential can replace potential source **10**, resistor **14**, capacitor **16**, and Zener diode **18**.

The oscillator which provides the requisite frequencies, comprises a unijunction transistor **19** having its upper base **21** connected through a resistor **20** to the high potential side of the capacitor **16** and its lower base **23** connected through a resistor **22** to the ground side of the capacitor **16**. The emitter **25** of the unijunction transistor **19** is connected to the selector arm of a selector switch **24** and also to one side of a second timing capacitor **26**. The other end of the timing capacitor **26** is connected to a second section **28** of the selector switch **24** which is ganged to be operable with the switch **24**, and also is connected through a second resistor **30** to ground. There is a third section **32** for the selector switch which is ganged to be operable with the other two. That is, sections **24**, **28** and **32**, constitute three selector switch sections which are ganged to be operable together.

The section **24** of the selector switch, when in its first position, as shown in the drawing, connects to a potentiometer **34** which is connected through a resistor **36**, to the source of operating potential **10**. When in its second position switch **24** connects through a potentiometer **38** which is connected in series with the resistor **44** to the source of operating potential **10**. When in its third position, the switch **24** connects to a potentiometer **40**, which is connected in series with the resistor **42**, which in turn is connected to the source of operating potential **10**. When it is in its fourth position the selector switch **24** connects to a potentiometer **45** which is connected to the source of operating potential **10**. Between the fourth contact positions of selector switch sections **24** and **28** there is connected a capacitor **46** in series with a potentiometer **48**.

Each one of the resistors and potentiometers which are

connected to the contacts of the selector switch section 24 together with the capacitor 26 and the resistor 30, perform the usual relaxation oscillator function of determining the time required to charge up the capacitor 26 to a value at which the unijunction transistor 19 is rendered conductive. At this time the capacitor 26 discharges through the unijunction transistor 19. The unijunction transistor 19 then is rendered nonconductive whereby capacitor 26 can charge up again. The frequency of oscillation of the relaxation oscillator arrangement described, is determined in accordance with well known principles and is adjusted precisely to the value desired by the trimming potentiometers 34, 38 and 40. Therefore, by selecting one of these positions the oscillator will oscillate at the frequency determined by the circuit component values thereby used.

The fourth position of the selector switch sections is employed when it is desired to obtain the low metronome frequencies. In the fourth position of the selector switch sections, capacitor 46 is connected in parallel with capacitor 26, thereby increasing the effective capacitance which must be charged up through potentiometer 44. Potentiometer 44 is adjusted to obtain the desired beat frequency. Potentiometer 48 is a trimmer potentiometer and is used for the purpose of compensating for variations which may occur in different unijunction transistors and in different values of capacitors used for capacitor 46 which latter components may have ±10% tolerances.

The output of the relaxation oscillator which has a somewhat sawtooth shaped waveform, is applied to the base of a transistor 50. The transistor amplifies the signal and its collector is connected both to the selector arm of the selector switch 32 and to one end of an inductance 52. The other end of the inductance 52 is connected to the fourth contact terminal of the selector switch section 32, and to one end of the voice coil of a loud-speaker 54. The other end of the loud-speaker voice coil is connected through a switch 56 to a source of operating potential 58, for the transistor 50. The switch 56 may be ganged to operate together with the switch 12. That is, whenever switch 12 is closed switch 56 is closed.

The first, second and third contacts of the selector switch section 32 are connected to first, second and third filter capacitor 60, 62, and 64. The purpose of the inductance 52 and the respective filter capacitors is to convert the sawtooth output signal of the relaxation oscillator to a sine wave signal which is then reproduced by the loud-speaker 54. No filtering and shaping action is provided when the selector switch is connected to its fourth position since, the waveform which is produced by the relaxation oscillator, when applied to the loud-speaker, sounds like the clicking sound of a metronome, which is exactly what is desired. A capacitor 64 is connected across the voice coil of the loud-speaker in order to bypass irritating high frequencies which may not be completely eliminated by the filter.

The circuit arrangement thus far described provides audio output signals which comprise the notes or tones required for tuning instruments. In addition, the circuit arrangement provides an audio output consisting of the beats of a metronome. The required notes for tuning are initially established in the instrument and then left unchanged. The metronome beats may be varied in frequency by means of the potentiometer 44. The instrument starts substantially immediately when the switches 12 and 56 are closed. The instrument maintains its output as long as switches 12 and 56 remain in their closed position. Thus, the person using the instrument need only start it after which he can tune his instrument and then turn off the device.

In addition to providing the functions of a metronome and an instrument tuner, the circuit shown may be combined with additional circuitry to provide the function of an indicator of whether a note being played is lower or higher than the standard tone provided by the circuit.

For this, a connection is made from the collector of transistor 50 to a first contact 70A of a two-position switch 70. When the switch 70 is moved to make connection with contact 70A, it connects the output of the transistor 50 to the anode of a diode 72, through D.C. blocking capacitor 119. The cathode of the diode 72 is connected to another unijunction relaxation oscillator circuit. This comprises the unijunction transistor 74 which has its first base connected through a resistor 76 to the source of operating potential and its second base connected through a resistor 78 to ground. Resistor 80 is connected in series wtih capacitor 82 which is connected in series with a potentiometer 84. The junction of resistor 80 and capacitor 82 is connected to the emitter of the unijunction transistor 74. Operating potential charges up capacitor 82 until it reaches a value at which a breakdown of the unijunction transistor 74 occurs. However, the potentiometer 86 is connected between the junction of resistor 80 and capacitor 82 and ground, for the purpose of biasing the oscillator circuit just below the point of oscillation when no input signal is applied thereto through the diode 72. In the presence of such signal, the oscillator synchronizes therewith and oscillates at the same frequency as the incoming signal applied thereto.

Unijunction oscillators have the unique feature that their output current is a linear function of the relaxation frequency. Thus, a direct current microammeter or milliammeter can be used to indicate frequency, once a calibration point is established. The purpose of the diode capacitor circuit shown connected to the potentiometer 84, is to rectify the output pulses from the relaxation oscillator and to apply these to the meter 90. Thus, the sliding contact of the potentiometer 84 is connected through a diode 92 to one side of the meter. The other side of the meter 90 is connected to ground. A capacitor 94 connects across the meter. The output of the second oscillator circuit, which is synchronized with the first oscillator circuit is therefore rectified and applied to the meter 90. The potentiometer 84 is adjusted so that the reading on the meter 90 is at center scale.

A microphone 96 is used to pick up the sound made by the person desiring to determine whether or not he is higher or lower than the standard note frequency selected by means of the selector switches 24, 28 and 32. The output of the microphone, after suitable filtering by series and shunt capacitors respectively 98, 100, is applied to the base of a transistor 102 to be amplified. The collector of the transistor 102 is connected to a source of operating potential through a resistor 104. Some feedback signal is applied between the collector and base of the transistor 102 through a resistor 106. The output of the transistor 102 is applied through a capacitor 108 to the base of a second amplifier transistor 110. The collector of this transistor is connected through the primary winding 112P of a transformer, the other end of which is connected to the source of operating potential. Series resistors 114, 116, which are connected across the operating potential source serve to apply a suitable cut-off bias to transistor 110 so that it will only produce an output in the presence of an input and will disregard noise perturbations. The secondary winding 112S of the transformer is connected to the second contact terminal 70B of selector switch 70. A load resistor 118 and capacitor 119 are connected across the secondary winding 112S.

After the person using the embodiment of the invention has selected a tone by means of the selector switches 24, 28, 32, and after he has centered the indicator on the meter 90 by means of the potentiometer 84, he then actuates the switch 70 to the position at which it connects contact 70B to the rectifier 72. The switches 12, 56 may be opened at that time or may be left closed to enable the audio output to continue. The person then commences to pluck the strings or make the sound next to the microphone 96 which he desires to corroborate with the reference note. This time the second oscillator will be synchronized or driven by the signal applied to the micro-

phone **96** and which is received through the secondary winding **112S** of the transformer. The meter **90** will indicate whether or not the signal frequency is higher or lower than the frequency of the standard signal. In this way the person using the instrument is informed as to which direction his tuning must take, or his singing must take, in order to be at the correct frequency.

In FIGURE 2, the meter **100** may be a less sensitive meter than the milliammeter **90** represented in FIGURE 1. A transistor **102** is then required to drive this less sensitive meter. In place of the meter **90** shown in FIGURE 1, the base of transistor **102** is connected to point B in the circuit shown in FIGURE 1, and point C of the circuit shown in FIGURE 2 is connected to point C of the circuit shown in FIGURE 1. A resistor **104** is connected between points B and C. The collector of the transistor **102** is connected to one side of the meter **100**. The other side of the meter **100** is connected to an operating source of potential **106**. The other side of the meter **100** is also connected to a resistor **108** whose other end is connected to the emitter of transistor **102**. The emitter of transistor **102** is connected to ground through a potentiometer **110**, which is made adjustable in order to establish the gain of the transistor **102**.

It is obvious that the frequency metering techniques described above can also be applied to measuring 60 c.p.s. and 400 c.p.s. power line frequencies and to a variety of industrial applications.

FIGURE 3 shows a circuit diagram of an arrangement for obtaining an audio output using a hearing aid type of transducer instead of a loud-speaker. This both enables the device to be made smaller and more portable as well as enables its use, as a metronome for example, without disturbing others. In place of all of the transistor **50** and its following circuitry, there is connected instead an NPN transistor which has its emitter connected to the junction of capacitor **26** and resistor **30**, its base connected to ground and its collector connected to a following volume control potentiometer **124** A hearing aid transducer **126** is connecetd between the potential source **10** and the volume control **12**. A capacitor **128** is connected between the transistor collector and ground.

The operation of the invention with the circuit shown in FIGURE 3 is the same as has been described previously. It performs as either a tuning aid or a metronome. The hearing aid transducer obviously is worn in the ear. The loudness level is adjusted by the potentiometer **124**.

There has been described herein a novel, useful and unique arrangement for providing the notes required for tuning instruments, for operating as a metronome, and for indicating whether or not the instrument being tuned is higher or lower than the standard notes being provided. The circuit arrangement requires a minimum of circuit components while providing an optimum in accuracy of operation, as well as reliability.

I claim:

1. An electronic tuning aid and metronome comprising a first variable oscillator, audio transducer means to which oscillations from said first oscillator are applied to be rendered audible, a second oscillator, visual indicator means connected to the output of said second oscillator to provide an output representative of its frequency of oscillation whereby an instrument may be tuned, means for synchronizing the frequency of oscillation of said second oscillator responsive to an applied signal, and switch means having a first position for connecting said means for synchronizing to said first oscillator output to synchronize said second oscillator frequency therewith whereby said visual indicator means provides a first indication thereof, and having a second position for connecting said means for synchronizing to said audio transducer means output to synchronize said second oscillator frequency therewith whereby said visual indicator means provides a second indication which if different from said

first indication enables the user to determine how to correct his tuning.

2. An electronic tuning aid as recited in claim 1 wherein said visual indicator means includes a meter, and potentiometer means coupled between the output of said second oscillator and said meter for adjusting the reading of said meter to provide a predetermined reading in response to said second oscillator output when it is synchronized with said first oscillator output.

3. An electronic tuning aid as recited in claim 1 wherein said first and second oscillators each comprises a relaxation oscillator including a unijunction transistor having a first and second base and an emitter electrode, two resistors, a capacitor, means connecting in series said capacitor between said two resistors, means connecting the emitter of said unijunction transistor to the connection between one of said two resistors and said capacitor, a source of operating potential, means for applying operating potential from said source across said unijunction transistor first and second base, means for applying operating potential from said source across said series connected two resistors and capacitors, and means for deriving an output from the other of said two resistors.

4. An electronic tuning aid and metronome comprising a variable reference oscillator comprising a unijunction transistor having a first and second base and an emitter, a capacitor, a resistor connected in series with said capacitor, and a first, second and third selector switch each having a plurality of contacts and a selector arm movable to connect to a different one of said contacts, means connecting the selector arm of said first selector switch to said unijunction emitter and to said capacitor, a plurality of resistors a different one of which has one end connected to a different one of said first selector switch contacts, a source of operating potential means for applying operating potential from said source across said unijunction transistor first and second bases and to the other ends of said plurality of resistors whereby said reference oscillator oscillates at a frequency determined by the one of said plurality of resistors which is selected by said first selector switch, another capacitor and another resistor connected in series between the last of said first and second selector switch contacts, an inductive impedance, a loud-speaker connected to one end of said inductive impedance, means connecting the selector arm of the third selector switch to the other end of said inductive impedance, means connecting the last contact of said third selector switch to the loud-speaker, a plurality of filter capacitors a separate one of which is connected to a different one of the remaining contacts of said third selector switch, and means for applying output signals from said variable oscillator to said other end of said inductive impedance.

5. An electronic tuning aid and metronome comprising a reference oscillator, means for varying the frequency of said reference oscillator to have a predetermined value, an audio transducer, a synchronized oscillator circuit comprising a unijunction transistor having an emitter, two resistors, a capacitor, means connecting in series said capacitor between said two resistors, means connecting said emitter to the connection between one of said two resistors and said capacitor, yet another resistor connected between said connection between said one of said two resistors and said capacitor and said other of said two resistors for preventing said synchronized oscillator circuit from oscillating in the absence of an input synchronizing signal, means for applying a synchronizing signal to said synchronized oscillator including a first contact connected to the output of said reference oscillator, a second contact connected to the output of said audio-electric transducer, and a swinger arm for alternatively connecting to said first or second contact, means connecting said swinger arm to said connection between said one of said two resistors and said capacitor, an output indicator connected to said other of said two resistors, and means

for establishing said output indicator in a reference indicating position when said swinger arm is connected to said first contact whereby when said swinger arm is connected to said second contact said output indicator indicates the frequency of any output from said audio-electric transducer.

6. An electronic tuning aid and metronome comprising a variable reference oscillator comprising a unijunction transistor having a first and second base and an emitter, a capacitor, a resistor connected in series with said capacitor, and a first and second selector switch each having a plurality of contacts and a selector arm movable to connect to a different one of said contacts, means connecting the selector arm of said first selector switch to said unijunction emitter and to said capacitor, a plurality of resistors a different one of which has one end connected to a different one of said first selector switch contacts, a source of operating potential, means for applying operating potential from said source across said unijunction transistor first and second bases and to the other ends of said resistors whereby said reference oscillator oscillates at a frequency determined by the one of said plurality of resistors which is selected by said first selector switch, another capacitor and another resistor connected

in series between the last of said first and second selector switch contacts, an audio transducer, a volume control potentiometer connected in series therewith, and means connecting said series connected volume control and audio transducer to said second selector switch variable arm and to the connection between said switch and said first capacitor whereby said audio transducer can provide an audible output representative of the output of said reference oscillator.

References Cited by the Examiner

UNITED STATES PATENTS

2,257,285	9/41	Sundt	84—454
2,958,250	11/60	Poehler	84—454
2,977,537	3/61	Wible	324—78 X
3,093,914	6/63	Bernstein	58—130 X

OTHER REFERENCES

Publication: "A Transistor Metronome," by Louis E. Garner, Jr., Radio and Television News (pages 50, 51, 158), January 1954.

LEO SMILOW, *Primary Examiner.*