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[54] **DEVICE FOR TESTING THE TUNE OF MUSICAL INSTRUMENTS**

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[51] **Int. Cl.** **G10g 7/02**

[58] **Field of Search** .... 84/454, 1.01, 1.16, DIG. 18, 84/464; 324/78 R, 78 F, 78 J, 81, 78 E, 78 Q

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[57] **ABSTRACT**

A device for testing the tune of musical instruments comprises an adjustable, active, band-pass filter for transmitting in-tune electrical signals and for rejecting out-of-tune electrical signals corresponding to tones of improper pitch produced by a musical instrument to be tuned. The device also includes an indicator operated in response to transmitted signals. The musical instrument, itself, may be provided with means for converting a generated musical tone to an electrical signal, which is then fed into the device, or the device may include such means.

5 Claims, 2 Drawing Figures

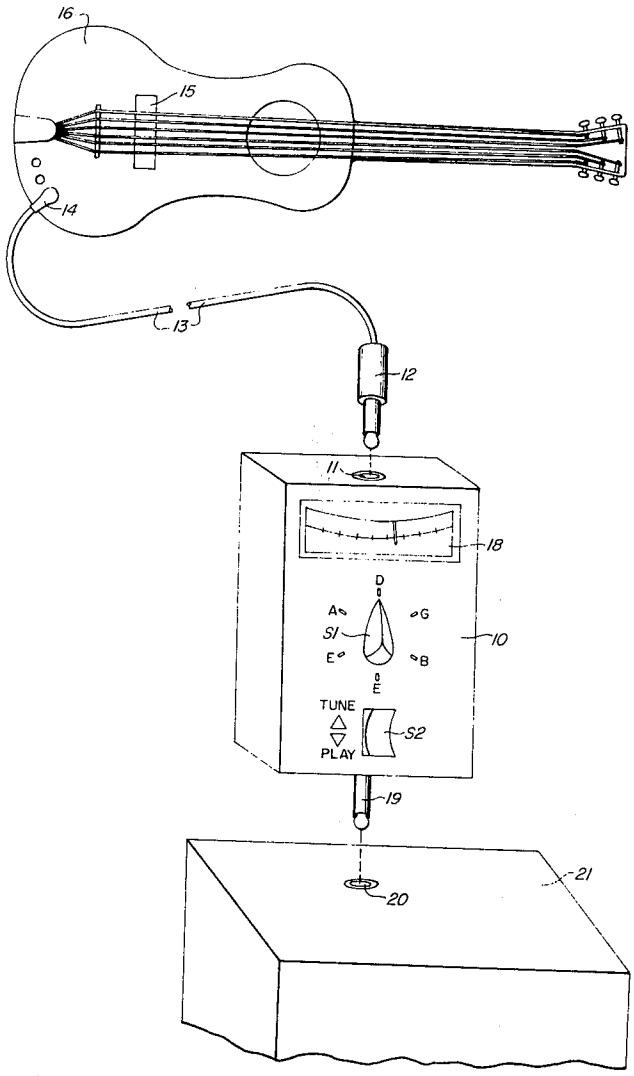


FIG. 1.

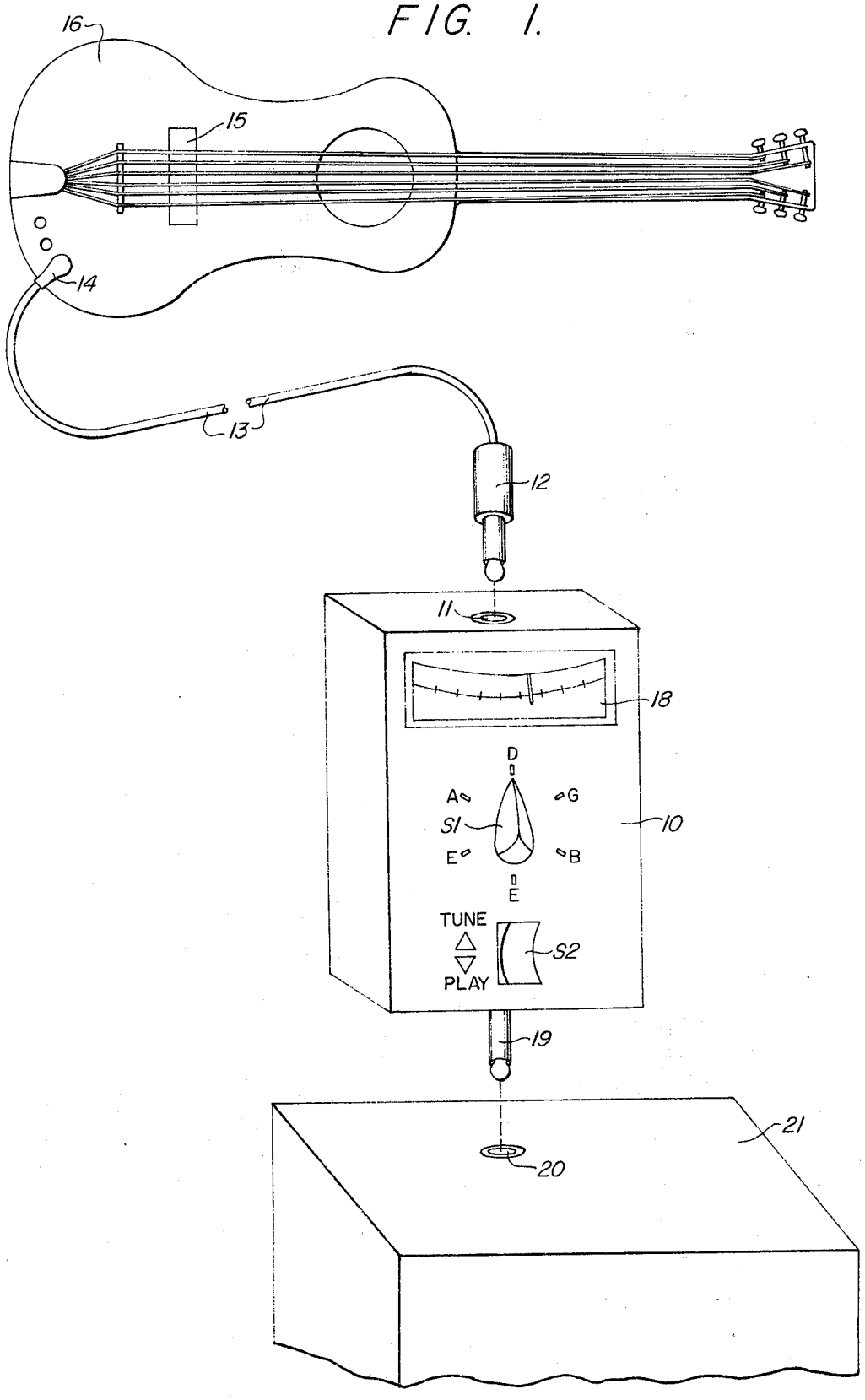
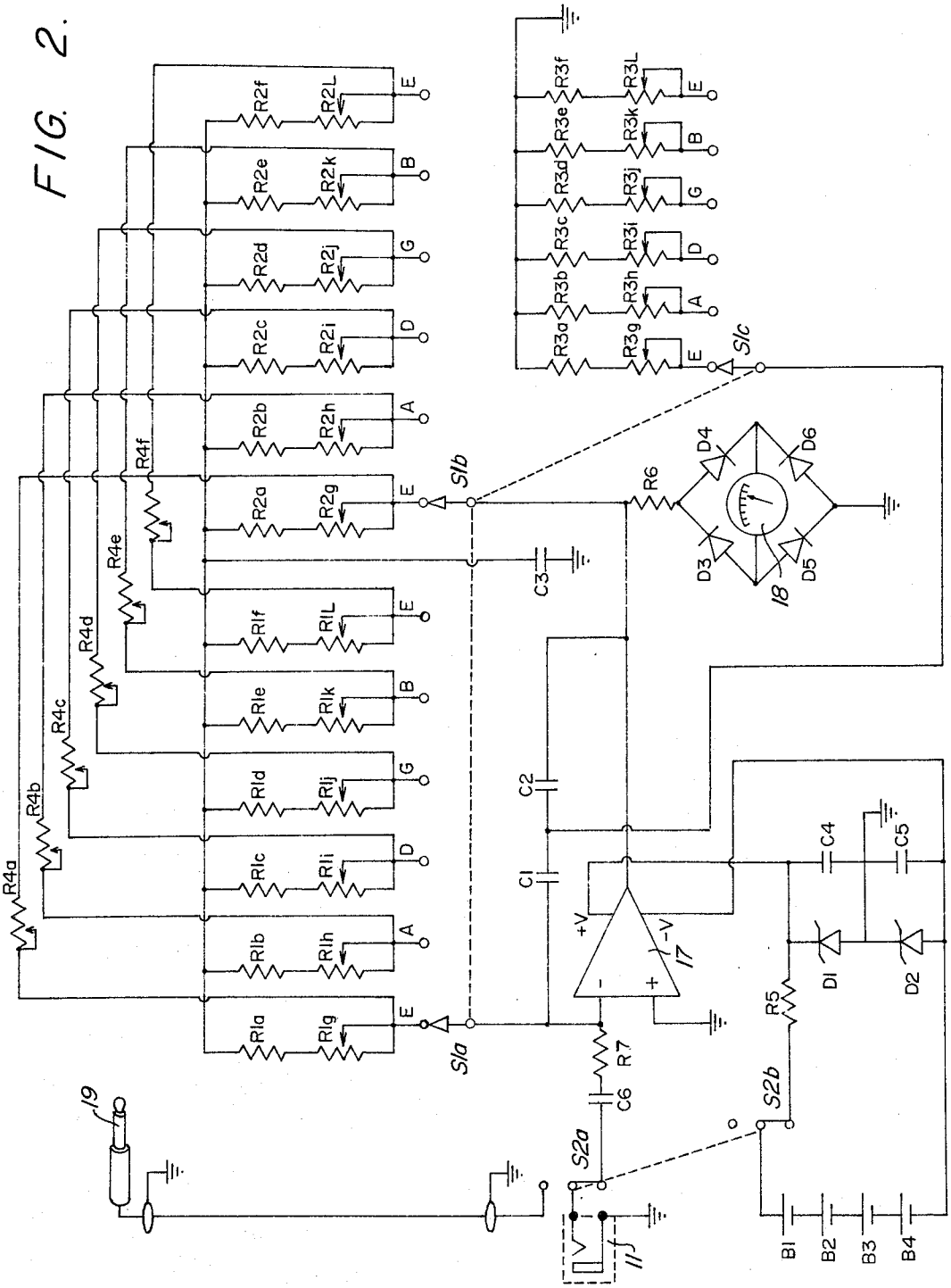


FIG. 2.


R1a
R1b
R1c
R1d
R1e
R1f
R2a
R2b
R2c
R2d
R2e
R2f
R1g
R1h
R1i
R1j
R1k
R1L
R2g
R2h
R2i
R2j
R2k
R2L
R3a
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R4f
R5
R6
R7
C1
C2
C3
C4
C5
C6
D1
D2
D3
D4
D5
D6
S1a
S1b
S1c
S2a
S2b
A
B
D
E
G
+V
-V
17
18
19
11
B1
B2
B3
B4

DEVICE FOR TESTING THE TUNE OF MUSICAL INSTRUMENTS

BACKGROUND OF THE INVENTION

Field

The invention is in the field of devices useful for testing the tune of musical instruments.

State of the Art

There have been numerous devices developed for aiding persons in properly tuning musical instruments. Most of these devices involve a complicated system for generating an electrical signal of frequency corresponding to the desired pitch of a musical tone and for comparing the generated signal with a corresponding tone produced by the musical instrument concerned. The musical instrument is adjusted until the pitch of the tone concerned corresponds exactly with the generated signal, at which time it is in tune. In a particular instance (U.S. Pat. No. 2,958,250), a passive band-pass filter is used in connection with such a frequency comparison system to cut out the fundamental tone when a harmonic thereof is being compared.

SUMMARY OF THE INVENTION

In accordance with the invention, a device for testing the tune of a musical instrument utilizes an adjustable, active, band-pass filter to transmit electrical signals of preset frequency and to block other signals. Means are provided to indicate when a signal is transmitted by the filter. Such means may be, for example, a meter which reads a particular value or reaches a maximum deflection, or may be a loudspeaker which produces a tone when a signal is transmitted.

The device also includes means for feeding, to the band-pass filter, electrical signals corresponding in frequency to the pitch of a tone produced by a musical instrument. For use with electrified instruments, such as electric guitars, which come equipped with an electrical pick-up for converting the sound made by the instrument into electrical signals, such feeding means is normally wiring connecting the pick-up to the filter. For use with non-electrified instruments, such feeding means normally includes an appropriate pick-up as well as the connecting wiring.

For use in tuning musical instruments, the filter is set to transmit a signal of a frequency corresponding to the desired pitch to be obtained from the instrument. The instrument is then played, and, if the frequency of the signal it produces corresponds to the set pitch, the signal is transmitted to the indicating means. If the signal is not transmitted, tuning of the musical instrument proceeds until the indicating means shows that transmission of the generated electrical signal has occurred.

THE DRAWINGS

The presently contemplated best mode of carrying out the invention is illustrated in the accompanying drawings in which:

FIG. **1** is an exterior perspective view of the device as constructed for use with electric guitars, both a guitar and its amplifier being indicated;

and

FIG. **2** is a schematic of the electronic circuitry of the device of FIG. **1**.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

The illustrated embodiment of the invention is specifically designed for use in the tuning of guitars, but it will be apparent that other embodiments of the invention can be constructed from the teachings hereof by those skilled in the electronic art for use in the tuning of any musical instrument.

Referring to FIG. **1**, in its illustrated form the device comprises a box **10** having an input jack **11** adapted to receive a plug **12**, which may be connected by standard wiring **13** and a plug **14** to a pick-up **15** of an electric guitar **16**. Pick-up **15** converts the musical tones produced by guitar **16** into electrical signals, whose frequency is the same as that of the pitch of the tone produced. On an electrified instrument, such as the electric guitar **16**, the pick-up referred to may be the normal one supplied with the instrument, as indicated. On a non-electrified guitar or musical instrument of any kind, the pick-up may be of any standard type or an ordinary microphone.

Within box **10** is located the circuitry of FIG. **2**, which includes an adjustable, active, band-pass filter, made up of operational amplifier **17**, capacitors C**1**, C**2**, and C**3**, fixed resistors R**1***a* to R**1***f*, R**2***a* to R**2***f*, and R**3***a* to R**3***f*, and variable resistors R**1***g* to R**11**, R**2***g* to R**21**, R**3***g* to R**31**, and R**4***a* to R**4***f*. Such band-pass filter is adjustable by means of a three-pole rotary switch S**1**, FIG. **1**, having the poles S**1***a*, S**1***b*, and S**1***c*, FIG. **2**, controlling introduction of sets of fixed and variable resistors into the circuit. Power is supplied by batteries B**1** to B**4** through resistor R**5**, Zener diodes D**1** and D**2**, capacitors C**4** and C**5**, and pole S**2***b* of a DPDT (double pole, double throw) of a rocker switch S**2**.

The circuitry also includes indicating means made up of meter **18**, diodes D**3** to D**6**, and resistor R**6**.

An output plug **19** from box **10** is adapted for plugging into input jack **20** of the usual amplifier **21** used with an electric guitar. This is a convenient arrangement, since the tuning device can be plugged in and left in place during normal playing of the guitar. Switch S**2** provides for checking tune of the guitar at any time the player wishes to do so.

In operation, electrical signals from pick-up **15** enter the band-pass filter through capacitor C**6** and resistor R**7**. Capacitor C**6** prevents any DC value that might be present from entering the filter, and resistor R**7** attenuates the signal to prevent overload or saturation of the filter and helps determine the gain of the amplifier. It is preferred that the time constant of the combination R**7** and C**6** be greater than the time constant of the filter circuit and that R**7** should be less than 100Kohms.

The band-pass filter utilized by this invention is an active filter, as contrasted with a passive filter. As shown in FIG. **2**, it is of the type known as a "twin-tee" filter; however, any type of filter network that can be adjusted to pass essentially a single frequency can be used.

In the "twin-tee" filter shown, the operational amplifier **17** is preferably a type **709** or **741**, such as a Fairchild u5B7709393 or u5B7741393. Type **741** is most preferred, because of its higher voltage gain and the fact that it does not need external frequency compensation.

Frequency control of the filter is achieved by reason of the various resistive and capacitive elements ar-

ranged in a twin-tee configuration and located between the output and input of the amplifier so as to provide feedback to the input of the amplifier. The twin-tee network includes the capacitors C1, C2, and C3, the fixed resistors R1*a* through R1*f*, R2*a* through R2*f*, and R3*a* through R3*f*, the variable resistors R1*g* through R11, R2*g* through R21, and R3*g* through R31, and the three pole rotary switch S1.

Capacitors C1, C2, and C3, are always connected in the circuit and are selected so that the impedance of C1 equals that of C2 within ±0.5 percent and that of C3 equals twice that of C1 within ±0.5 percent. The capacitance values are much larger than any possible stray capacitances in the circuit, so that such stray capacitances are effectively absorbed by the larger capacitors and do not affect the frequency characteristics of the circuit. The preferred values of C1 and C2 are 0.1 uF and the preferred value of C3 is 0.2uF.

As previously indicated, sets of fixed and variable resistors are selectively placed in the filter circuit by means of switch S1. There are six positions of the switch, a position for each string of guitar 16. In each position of the switch, three sets of the resistors are electrically placed in the circuit, each pole of the switch connecting one set into the circuit. The variable resistor of each set is used in setting the exact frequency of the filter to correspond to any given in-tune musical note.

In FIG. 2, the six positions of the switch are designated E, A, D, G, B, and E respectively, each letter representing the in-tune note of one of the six open strings of guitar 16. Poles S1*a*, S1*b*, and S1*c* are shown in the first position E. In such position the set of fixed resistor R1*a* and variable resistor R1*g* is placed in the circuit by switch pole S1*a*; the set R2*a* and R2*g* by pole S1*b*; and the set R3*a* and R3*g* by pole S1*c*. The amount of resistance placed in the circuit determines the trapped, i.e., resonant, frequency of the twin-tee network of the filter. A different value of resistance is required for tuning each sound-producing element of a musical instrument.

Poles S1*a* and S1*b* also selectively place feedback variable resistors R4*a* through R4*f* in the filter circuit. One of these resistors is placed in the circuit in each position of switch S1. With S1 in position shown, R4*a* is in the circuit. The purpose of the feedback resistors is to always provide enough negative feedback to the operational amplifier to prevent it from becoming unstable and oscillating. The particular values of resistance used depend upon the particular type of operational amplifier used.

The twin-tee arrangement of capacitors and resistors provides a negative feedback signal to the input of the operational amplifier. At the resonant frequency of the twin-tee, as varied by the resistance in the circuity, a minimum amount of negative feedback appears at the input to the amplifier, thereby making the gain through the amplifier maximum. The gain (output voltage divided by input voltage) of the circuit of FIG. 2 is approximately constant over its six selectable resonant frequencies. Using a 709 type operational amplifier, the gain is about 3700 or 71dB. The Q of a filter circuit is defined as the resonant frequency of the filter divided by the bandwidth of the pass curve at a point 3db down the curve. For example, in the circuit of FIG. 2, using a 709 type operational amplifier, with the switch S1 set in the D position corresponding to a frequency of 146.8 Hz. the bandwidth at 3db down the curve is 0.38 cycles, making the Q equal to 386. The Q of the circuit will vary in each position of switch S1, but with the circuit shown, stays above 100. If a 741 operational amplifier is used, the gain is increased and the Q increased.

The value of Q is not critical. However, a higher Q (meaning a sharper pass curve) will result in a more accurately tuned pitch.

In the illustrated embodiment, resonant frequencies of the twin-tee arrangement are designed to correspond to the open string frequencies of the six guitar strings. These frequencies are:

E	82.4 Hz.
A	110.0 Hz.
D	146.8 Hz.
G	195.9 Hz.
B	246.9 Hz.
E	329.6 Hz.

To achieve the above frequencies, the values of the resistors in the filter circuit of FIG. 2 are as follows:

Fixed	
R1*a*, R2*a*	18k ohms
R1*b*, R2*b*	16k
R1*c*, R2*c*	11k
R1*d*, R2*d*	8.2k
R1*e*, R2*e*	6.8k
R1*f*, R2*f*	4.7k
R3*a*	8.2k
R3*b*	5.6k
R3*c*	4.3k
R3*d*	3.3k
R3*e*	2.7k
R3*f*	2.0k
Variable	
R1*g*, R2*g*, R1*h*, R2*h*, R1*i*, R2*i*	2.5k
R1*j*, R2*j*, R1*l*, R2*l*, R3*g*	1k
R1*k*, R2*k*, R3*i*	500 ohms
R3*h*, R3*j*, R3*k*, R3*l*	250 ohms
R4*a* through R4*f*	15k

The variable resistors are adjusted until the exact resonant frequencies are obtained. This is normally done in the manufacture of the device. The person using the tuning device does not adjust the resistors. The use here of variable resistors is merely a practical way to achieve exact circuit resistances in a production environment.

The output of operational amplifier 17 is connected to resistor R6 of the indicating means, which in turn, is connected to the full wave rectifying bridge comprising diodes D3 through D6. Meter 18 is connected across the bridge. The signals from the band-pass filter are rectified by the diode bridge and the meter is deflected by the rectified current. It is preferred that resistance value of R6 be selected so that the maximum output of the filter will cause a meter deflection of about 90 percent. However, R6 could be selected to give any desired maximum deflection.

Many types of indicating means can be used. For example, a lamp which goes on when a certain voltage is applied across it could be substituted for the meter in the bridge circuit and R6 adjusted so that maximum output of the filter would produce the necessary voltage. Again, the entire indicating means shown in FIG. 2 could be replaced by a loudspeaker. The output of the filter would then cause the loudspeaker to produce a tone which would reach maximum volume with maxi-

mum filter output. It should be realized that many other indicating means could be used.

With switch S2 in the position shown, pole S2*b* is closed so as to connect batteries B1, B2, B3, and B4 with the rest of the power supply circuit. These batteries are each nine volts and of the type commonly used in transistor radios.

The batteries are connected in series to produce a total of 36 volts. Zener diodes D1 and D2 are rated at 16 volts and biased by R5, so that they carry only about one quarter as much current as the operational amplifier. R5 drops about 4 volts, leaving 16 volts across each Zener diode. As the batteries weaken with use and age, the Zener diodes continue to drop a constant 16 volts each. However, the voltage dropped by R5 decreases. The ground connection between diodes D1 and D2 enables the power supply to provide +16 volts and −16 volts with respect to ground. The capacitors C4 and C5 prevent any undesirable AC signals that might feedback through the power supply from being transmitted along with the DC to the operational amplifier.

Pole S2*a* of switch S2, in the position shown, connects jack 11 to the circuitry of the band-pass filter. If switch S2 is placed in its alternate position, jack 11 is directly connected electrically to the output plug 19 of box 10 by pole S2*a*. Pole S2*b* in this position opens the power supply circuit, so that no power is supplied to amplifier 17. Switch S2 acts as an "on-off" switch, and also, when it is "off" position, causes the signals from the instrument to by-pass the tuning circuitry and to proceed directly from jack 11 to plug 19.

In using the illustrated device as interconnected between guitar 16 and its amplifier 21, switch S2 is pushed into its tune position whenever the player wishes to test the tune of the guitar. Switch S1 is rotated to the position corresponding to the guitar string (E, A, D, G, B, or E) desired to be tuned. The string is plucked and the response of meter 18 watched. If out of tune, tension of the string is adjusted in the usual manner until the meter reaches a maximum deflection, indicating that the string is in tune. Switch S1 is then rotated to the position corresponding to the next string to be tuned, and that string is adjusted until the meter indicates that it is in tune. This process is repeated until all strings have been tuned. Thereupon, switch S2 is switched to play position, and normal play is resumed. Anytime it is desired to retune the instrument, S2 is again switched to tune, the guitar tuned if required and switch S2 then returned to play position.

Although this detailed description is specific to guitar tuning, it is obvious that the device can be adapted for use with any musical instrument. Switch S1 or a plurality of similar switches would provide a position for each sound-producing part of the instrument. Such switch or switches would position various resistances in the filter circuit so that the pass frequency of the filter would correspond to the in-tune note produced by the particular part of the instrument concerned. The values of the resistances necessary can be found by ordinary calculations performed by anyone skilled in the electronics art. If a large range of notes is to be covered, such as in the tuning of a piano, the capacitance values of the filter circuit may also be changed selectively in similar manner.

Whereas this invention is here illustrated and described in detail with respect to a preferred specific embodiment thereof, it should be understood that various changes may be made without departing from the inventive concepts as defined herein and particularly pointed out in the claims.

What I claim is:

1. A device for testing the tune of musical instruments comprising a precalibrated, stepwise adjustable, active, band-pass filter for transmitting at any given time an electrical signal of substantially predetermined frequency blocking other signals; indicating means arranged to be operated in response to signals transmitted by said band-pass filter; means for feeding to the band-pass filter electrical signals corresponding in frequency to the pitch of a tone produced by a musical instrument; by-pass circuitry interconnectable with the feeding means; means for connecting said by-pass circuitry with an output amplifier; and switching means for connecting either said band-pass filter or said by-pass circuitry with said feeding means; and means for providing power to the band-pass filter.

2. A device in accordance with claim 1, wherein the band-pass filter comprises circuitry of twin-tee type.

3. A device in accordance with claim 2 wherein the twin-tee circuitry comprises fixed capacitors, sets of fixed and variable resistances, and at least one selection switch for operatively connecting certain of said sets at any given time.

4. A device in accordance with claim 3, wherein the values of the fixed capacitors are symmetrical.

5. A device in accordance with claim 1, wherein the means for connecting said by-pass circuitry with an output amplifier is a standard male plug, and wherein the device is mounted in a housing rigidly connected to said plug whereby the device is held in place when said plug is connected to the output amplifier.

* * * * *