crystal-controlled stroboscope

Gramophone records are supposed to be played at exactly 33 1/3, 45 or 78 RPM, as the case may be. Nowadays it is usual for record player manufacturers to leave the final calibration of their product to the user, by providing a 'fine speed control'. However, this means that the user needs some clear indication of the turntable speed and common practice is to include a stroboscope with a speed calibration disc. This is very cheap and extremely accurate — provided the stroboscope is running at the correct frequency! Normally the mains frequency is used, but this is not as reliable as one might expect. A crystal-controlled stroboscope is a far more accurate solution.

Why it is so essential for a turnable to have the correct speed? Well, for the simple reason that the slightest deviation will affect all the frequencies and tempi on the record. In other words, the pitch may change. This can, of course, lead to various interesting 'special' effects, but it is hardly 'high-fidelity'!

The above can be avoided by using a crystal-controlled stroboscope. This can be used to calibrate the turntable speed if some means of motor speed adjustment is provided. This type of record player is often equipped with a separate stroboscope disc (see figure 1) that can be placed on the turntable. When this is illuminated by a (mains driven) light bulb, a correct speed adjustment will produce a stationary image. Alternatively, the stroboscope may be situated on the rim of the turntable (figure 2). It is then lit by a small built-in lamp which is connected to the mains.

Unfortunately, mains powered stroboscopes suffer from a couple of disadvantages. First, the mains frequency is not very constant over a short period of time (only long-term accuracy is required to keep clocks and the like running on time). In the second place, the image which appears on the stroboscope disc is often rather blurred. This is because the stroboscope lamp is supplied with a sine wave derived from the mains, which causes a fairly slow transition to take place from light to dark, and vice versa. This effect is aggravated by the length of time it takes the light bulb to light up and then fade. It means the brightness is fairly evenly distributed throughout the period that the bulb is lit, so that no peak intensity will be reached. As a result, the image on the disc is bound to become 'fuzzy'. Better results can be obtained with a neon bulb, although the mains frequency will of course still be inaccurate. Even better is to use a crystal-controlled stroboscope. Having a crystal act as a reference source enables the speed to be adjusted with maximum precision.

In this circuit the disc is illuminated by three red LEDs. These have an ad-

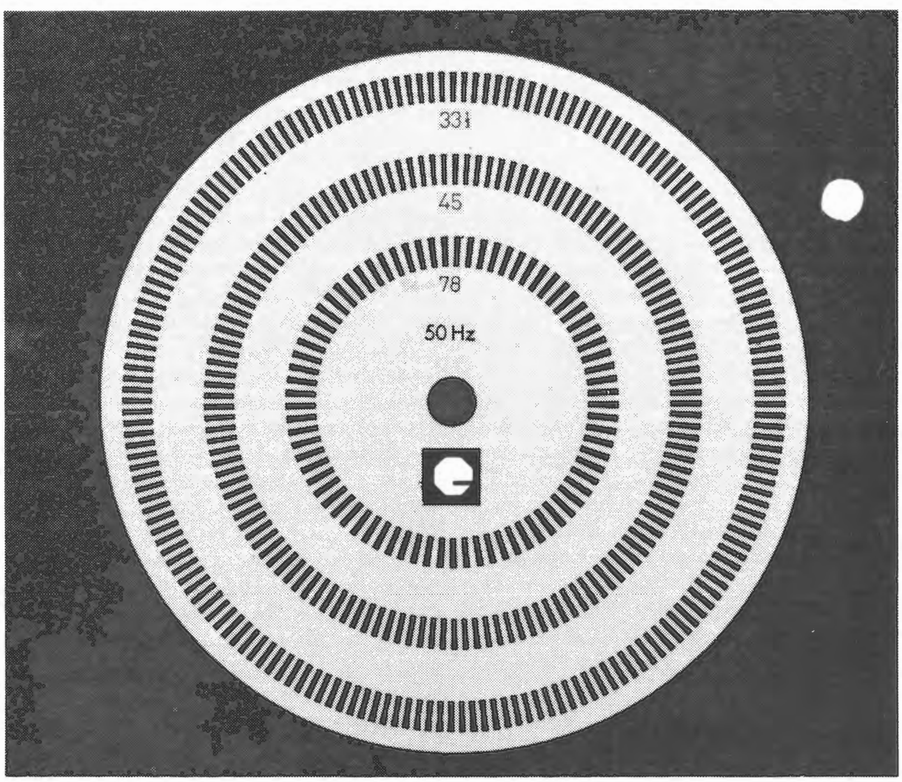

Figure 1. A full-size stroboscope disc used to adjust 33 1/3, 45 and 78 RPM on record players. The 50 Hz indicated refers to the mains frequency for which the disc was designed.

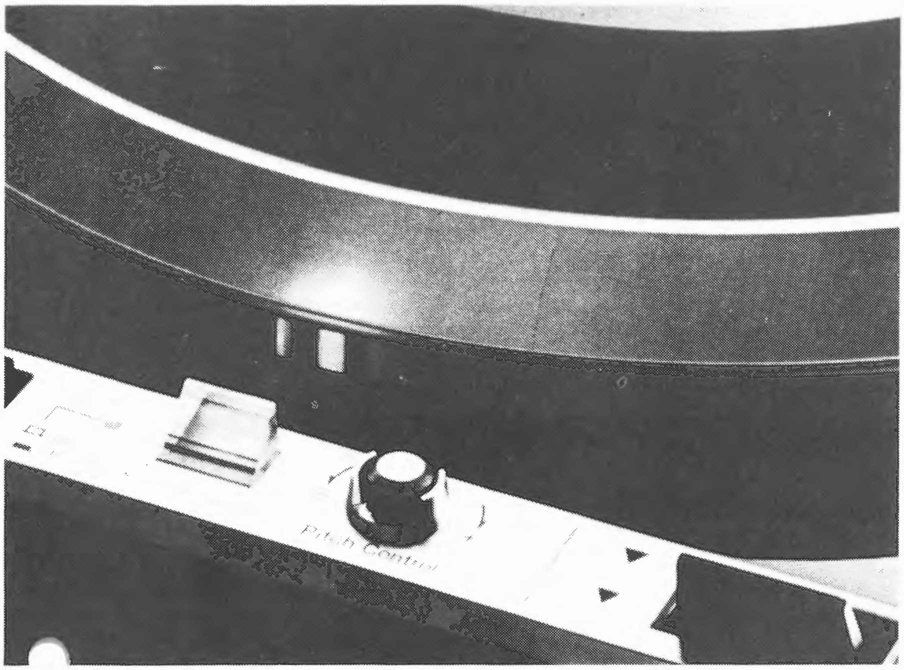

Figure 2. A stroboscope that is printed on the rim of the turntable. This particular record player has its own light source.

vantage over normal light bulbs, in that they light up and extinguish very quickly, creating a clearly outlined image. The effect is heightened by powering the LEDs from a square wave voltage with an amplitude in the 9 . . . 12 volt range. The crystal stroboscope will then produce a symmetrical 'square wave' light output, in other words, it has a clearly defined light-to-dark ratio.

Stroboscope discs are normally designed for an illumination frequency of 100 Hz. This may sound surprising, as the frequency of the mains voltage is 50 Hz. Nevertheless, a lamp (or neon lamp) lights up every half period, so that the illumination frequency will be double the mains frequency (100 Hz).

The circuit diagram

The crystal stroboscope (see figure 3) is fairly straightforward, as can be seen from the circuit diagram. IC1 contains an oscillator and a 2^{14} divider. Provided the oscillator loop is correctly calibrated with C1, the output (Q_{14}) will produce a 200 Hz square wave (3.2768 MHz ÷ 2^{14} = 200 Hz). The square wave voltage is divided by 2 by IC2 and the 100 Hz frequency, required to switch the LEDs on and off, will appear at the base of T1.

Resistor R3 has a low value to allow plenty of current to pass through the LEDs and so provide sufficient light.

Since the device only consumes about 25 mA, it can be battery-powered.

Calibration

A precise frequency meter — perhaps you can borrow one? — is an absolute must where calibrating the stroboscope is concerned, as it needs a 6-digit display at least. The frequency meter is connected to testing point TP (pin 7 of IC1). Trimmer C1 is then used to adjust the frequency to exactly 204,800 Hz. If a frequency meter is not available, C1 can either be placed in the middle position or be replaced by a fixed 12 pF capacitor. The frequency deviation will then be not more than 0.01%.

Construction

Once the circuit has been built (on Veroboard, for instance) and calibrated, it can be inserted into an (old) torch. There will often be enough room for a 9 V 'power-pack' battery as well. The switch on the outside of the torch can then act as S1. The three LEDs are mounted very close together in the torch bulb's place. If your record player already has a stroboscope (either a bulb or a neon lamp), this can be replaced by the crystal-controlled version.

It should be noted that the speed must be adjusted while a record is playing. Place the record on the turntable first and the disc on top of it. The disc's diameter may not exceed that of the record label, as otherwise the running-out groove will be covered.

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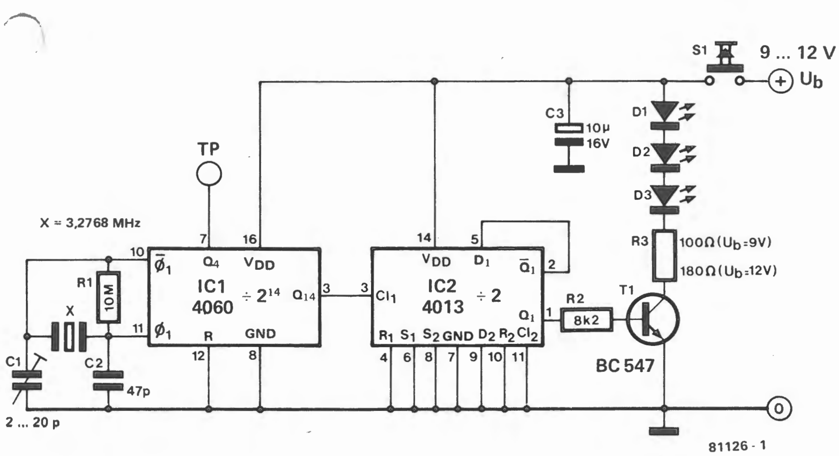

Figure 3. This crystal-controlled stroboscope makes it possible to adjust the speed of a record player with great precision. The LEDs, supplied with a square wave voltage, produce a better, clearer image than any light bulb or neon lamp would; furthermore, the mains frequency is not as accurate.