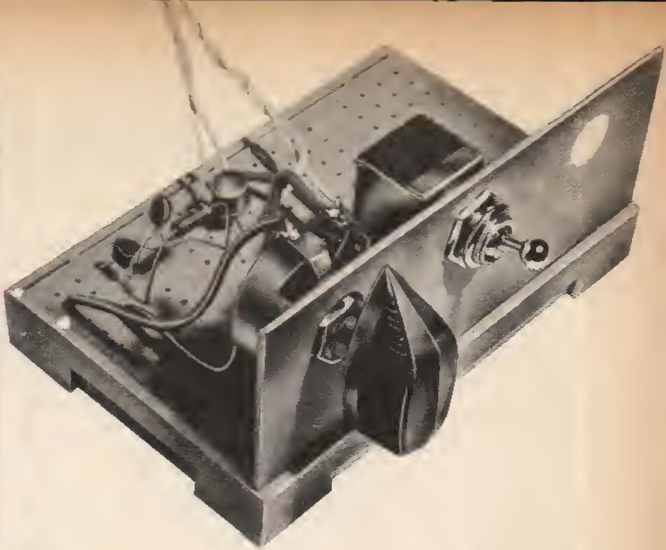


To study a musical instrument, one of the most important requirements is strict attention to playing speed. To assist in the correct interpretation of the music's tempo the composer conveniently heads his composition with a rough guide to the rate at which it should be played like *Andante* or *Allegro*, this usually being followed by the number of crotchets, quavers, etc. that should be played per minute.

Whilst the accomplished musician has little difficulty in interpreting these tempo marks, the beginner does need some sort of aid to assist in establishing a sense of time.

More than a hundred years ago Maelzel provided such an aid in his invention of the mechanical metronome which produced loud ticks with the movement of a weighted pendulum. With the simple electronic metronome to be described, we can reproduce these ticks just as effectively without the labour of winding up springs.

RELAXATION OSCILLATOR

To simulate the sound of its mechanical counterpart the circuit of Fig. 1 was designed to produce asymmetric pulses of short width and rapid rise and fall times. The pulse generated across the loudspeaker LS1 is shown in this diagram, and it ensures a very rapid cone movement.

The frequency range extends from 40 to 220 beats per minute, which is adequate.

As this little device is very precise in its counting, it can also be used as an audible "darkroom" timer when set to 60 beats/minute.

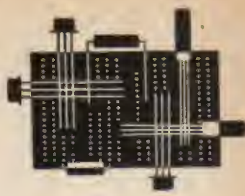
The circuit itself is a simple relaxation oscillator where two complementary *npn* and *pnp* transistors are made to switch on and off at a rate determined by the resistance chain VR1, R1 and capacitor C1. With S1 closed, C1 charges until it reaches about 650mV when TR1 is switched on and immediately discharges the capacitor.

The current pulse produced by TR1 in turn switches on TR2 with the result that almost the whole of the supply voltage is made to appear across the loudspeaker.

The actual discharge time of the capacitor depends on the base-emitter impedance of TR1, the loudspeaker impedance and the output impedance of TR2 which collectively account for the exponential hump on the output pulse waveform.

With the completion of the pulse the capacitor again charges to the conduction potential of TR1, when the pulse cycle starts again.

METRONOME



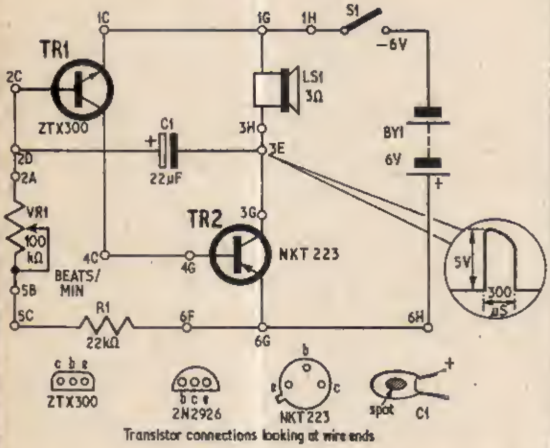


Fig. 1. Circuit diagram of the metronome showing the T-Dec hole connections, transistor wire identification and output waveform

COMPONENTS . . .

Resistors
R1 22kΩ 10% ½ watt carbon

Potentiometers
VR1 100kΩ linear carbon

Capacitor
C1 22µF tantalum elect. 16V

Transistors
TR1 ZTX300 (Ferranti) or 2N2926 orange spot
TR2 NKT223 (Newmarket) or GET102 (Mullard)

Switch
S1 on/off toggle switch

Loudspeaker
LS1 3Ω 5in permanent magnet moving coil unit

Battery
BY1 6V type 996

Miscellaneous
T-Dec.
Single strand connecting wire
Battery connectors or clips

LOW LEAKAGE

In the application of this unit timing precision is important. The simple factor most likely to give trouble in this aspect is leakage current. The choice of a silicon transistor for TR1 and a tantalum electrolytic capacitor for C1 virtually eliminates the problem.

In the choice of speaker it will be found that sound output is a function of cone diameter. In practice, a 5in speaker proved very satisfactory.

CONSTRUCTION

Construction of the unit merely involves plugging the components into the T-Dec as shown in the photograph. For the holes employed refer to Fig. 1, which shows the hole numbers for each junction.

If it is intended to make a permanent unit of this, the wiring configuration will readily translate to any of the board constructional methods outlined in the introductory article.

If such construction is undertaken the potentiometer setting must be calibrated in terms of the number of beats produced per minute. Using a wrist watch with seconds sweep or preferably, a stop watch, the potentiometer should be advanced at 20 beat intervals. These positions can be recorded on a piece of white card. A pointer knob attached to the potentiometer shaft will simplify this operation.

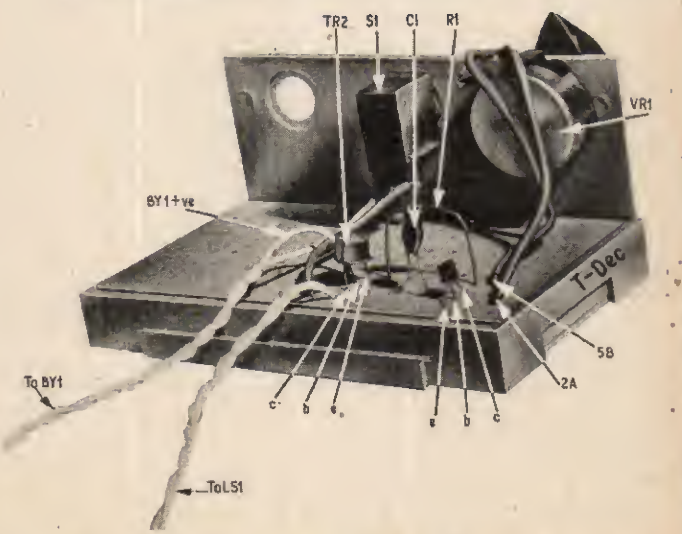


Fig. 2. The layout of components on T-Dec. Make sure the battery is correctly connected