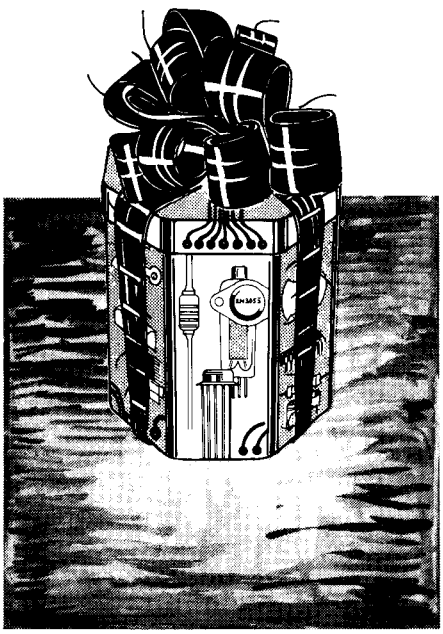
Music box

This simple little circuit can be used to make an amusing musical toy in the form of a drum which, when rolled along the ground, will play a musical scale, nursery rhyme or other tune.

M. Bolle



The complete circuit of the music box is shown in figure 1. N1 to N3 comprise an oscillator consisting of an integrator (N1) and a Schmitt trigger (N2 and N3). When the output of N3 is low the output of N1 ramps positive until the upper threshold of the Schmitt trigger is reached. The output of N3 then goes high and the output of N1 ramps negative until the lower threshold of the Schmitt trigger is reached, and so on. An output buffer amplifier T1/T2 drives a loudspeaker.

The rate at which the integrator capacitor C1 charges and discharges, and hence the oscillator frequency, is inversely proportional to the integrator time constant R x C1, where R is the resistance between the output of N3 and the input of N1 (R1, R6 to R16).

The frequency of oscillation is given by:

$$f_0 = \frac{1}{2C_1 R}$$

C1 is fixed, so each note which the music box plays is determined by switching in a different value of R, using reed switches which are activated by a magnet. The resistance values shown will make the music box play a tonic sol-fa scale of an octave and a half, but simple tunes may also be played if the resistance values are calculated accordingly using the following data:

$$R = \frac{1}{3 \times 10^{-5} \times f_0}$$

where R is in kΩ and f_0 is in Hz.

Note		f_0 (Hz)	R(k)	Made up of
Middle	C	261.6	127	100 + 27
	C#	277.2	120	120
	D	293.6	113	100 + 13
	D#	311.12	107	68 + 39
	E	329.6	101	use 100 k
	F	349.2	95	68 + 27
	F#	370.0	90	68 + 22
	G	392.0	85	75 + 10
	G#	415.3	80	47 + 33
	A	440.0	76	56 + 20
	A#	466.2	71	56 + 15
	B	493.9	67	56 + 11

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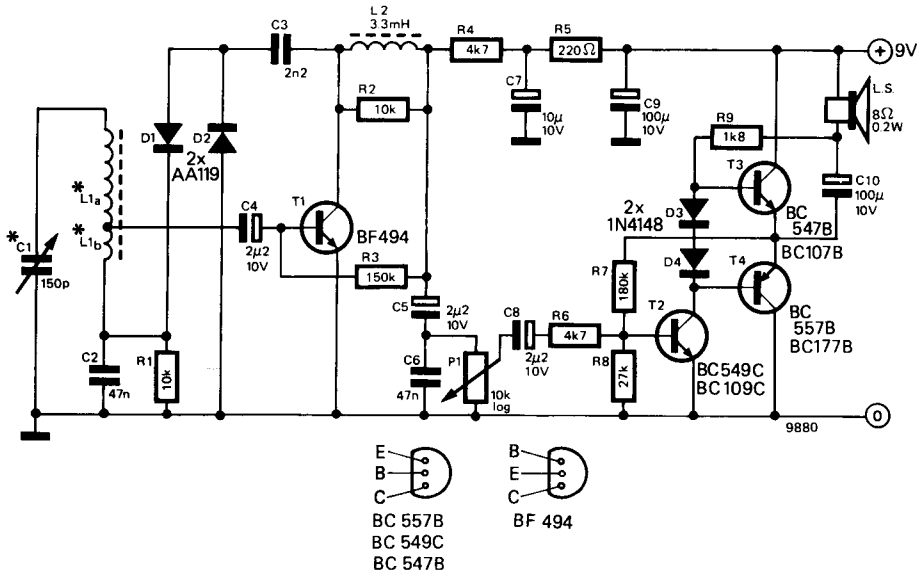

*see text

L1 = 8 + 87 turns 0.2 mm wire (38 SWG) on ferrite core (see text)

bottom view

Figure 1. Circuit of the MW reflex receiver, which uses the simplest circuit consistent with reliable operation.

Figure 2. Printed circuit board and component layout for the receiver. To ensure reliable operation this layout should not be altered.

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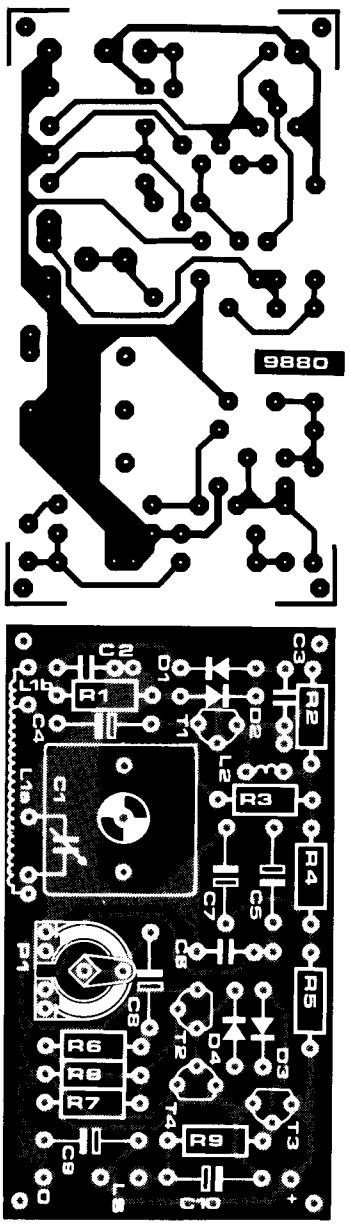

Small trimmer capacitors are also built in, connected in parallel with the main sections, and the trimmer in parallel with the 150 pF section is used in the alignment. With regard to the other components, it should be noted that, since the circuit is an absolutely 'minimum component' design, values are quite critical and only those specified should be used.

Alignment

When the set has been completed and the construction checked, it can be switched on, when it should be possible to receive several stations by adjusting the tuning capacitor. The only alignment required is to ensure that the tuning (from one extreme setting of C1 to the other) covers the 550 kHz to 1600 kHz medium-wave band. The alignment procedure is very simple:

1. Set C1 so that the vanes are fully open, and adjust the trimmer until a station is received whose frequency is

Parts list for figures 1 and 2

Resistors:
R1, R2 = 10 k
R3 = 150 k
R4, R6 = 4k7
R5 = 220 Ω
R7 = 180 k
R8 = 27 k
R9 = 1k8

Capacitors:
C1 = 150 p solid dielectric miniature tuning capacitor
C2, C6 = 47 n
C3 = 2n2
C4, C5, C8 = 2µ2/10 V
C7 = 10 µ/10 V
C9, C10 = 100 µ/10 V

Semiconductors:
T1 = BF 494
T2 = BC 109C, BC 549C, or equ.
T3 = BC 107B, BC 547B, or equ.
T4 = BC 177B, BC 557B, or equ.
D1, D2 = AA 119
D3 D4 = 1N4148

Miscellaneous:
L1 = ferrite aerial (see text)
L2 = 3.3 mH miniature r.f. choke
P1 = 10 k log. potentiometer
8 Ω/200 mW miniature speaker, size to suit personal taste.

Figure 1. Circuit of the music box.

Figure 2. The music box is housed in a cylindrical drum. When this is rolled along the reed switches close as they move past the magnet.

Resistance values for notes an octave above this range are found by simply halving the resistance values given here.
It should be noted that, due to tolerance in the oscillator components and in the threshold levels of the NAND gates, the exact frequencies calculated may not be obtained. However, provided reasonably close tolerance resistors are used for 'R', the correct musical intervals of the scale will be achieved.
Alternatively, a preset potentiometer may be included in series with every resistor to tune each note precisely.

Construction

The circuit is housed in an empty coffee tin or similar cylindrical container (figure 2). First, a piece of Veroboard is cut to the same diameter as the container, and the circuit is built up on this with the 12 reed switches (or how ever many are required for the desired tune) spaced around the periphery. A hole is drilled at the centre of the board which accepts a bolt to act as a pivot for the magnet, which is suspended at the end of a Meccano (or similar) strip.
The base of the tin is pierced with holes, and the loudspeaker is mounted at the bottom of the tin, with the leadout wires taped to the side of the tin to avoid fouling the magnet. The circuit board is then mounted about one third of the way down the tin, and finally the battery, which can be a PP3 or other small 9 V battery.
So that the drum will roll freely the battery should be fixed with its centre of gravity coincident with the axis of the drum.
When the drum is rolled along the reed switches will rotate past the magnet and be activated sequentially, thus playing the tune. Of course, if the drum is rolled the wrong way the tune will be played backwards, so it is a good idea to paint an arrow on the drum to indicate the direction of rotation.
One important point to note is that the magnet should not be too powerful, nor should the reed switches be too close together, otherwise more than one may be activated at once.

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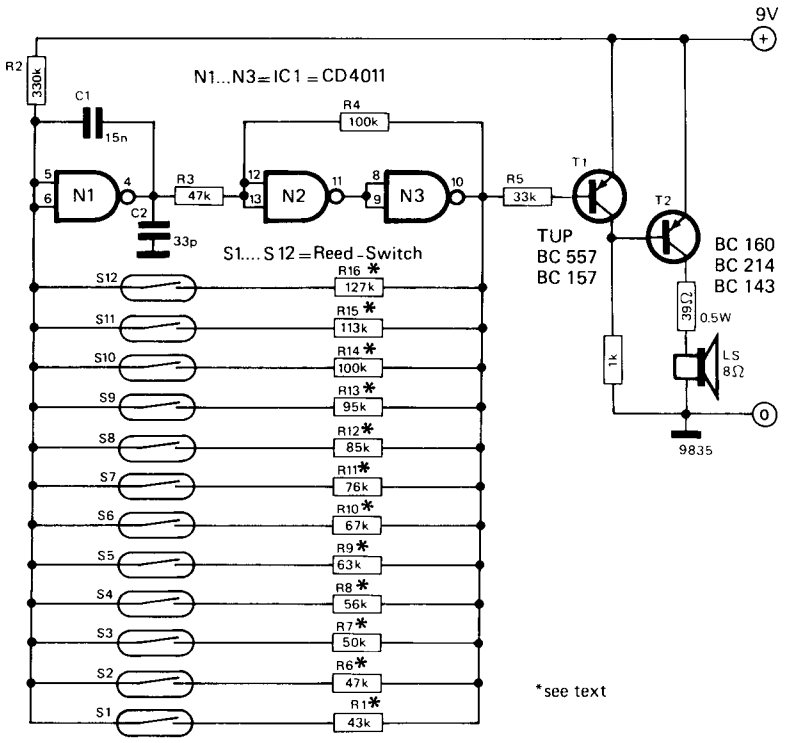

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