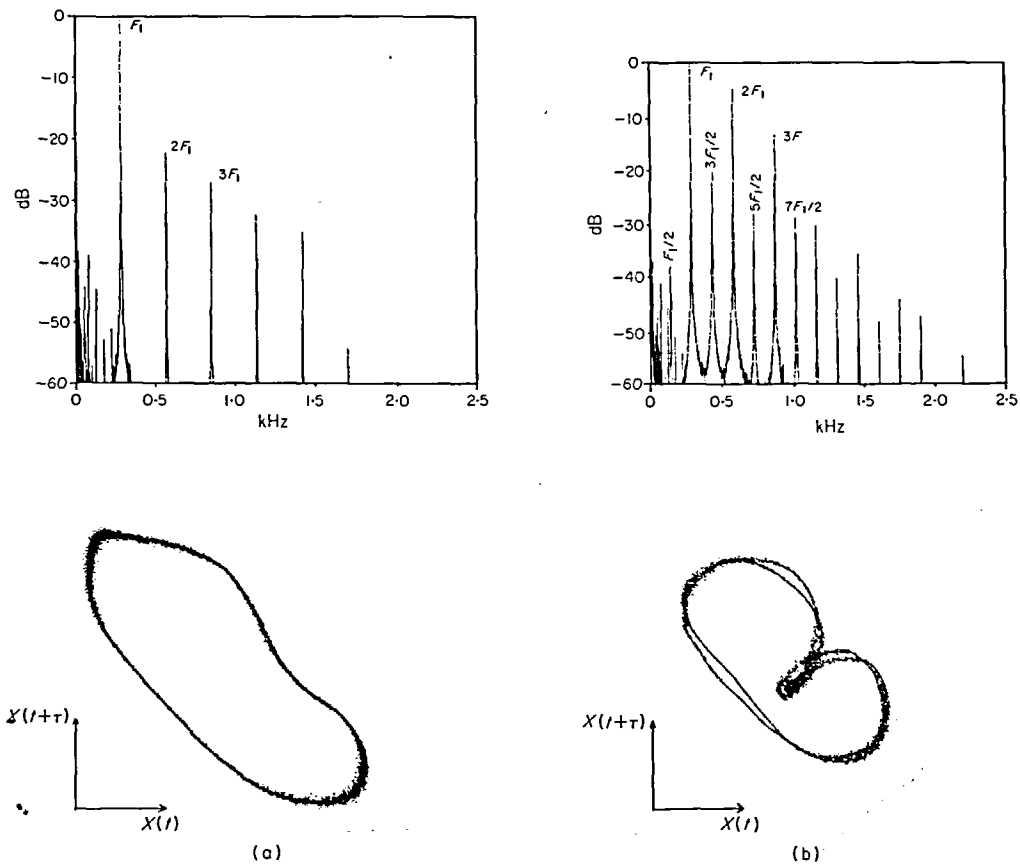

Figure 2. (a) Periodic oscillations observed in a Fourier representation (upper part) and phase space (lower part; the time delay τ is equal to 4×10^{-4} s; for more details, see the text). (b) Signal observed in the same conditions as in Figure 2(a) but with a higher gain G; a period doubling is clearly visible.

oscillation. It contains 0·8 seconds of the electrical signal sampled at a 10 kHz rate; the delay τ is 4×10^{-4} s. One notes the presence of even harmonics in the spectrum, despite the fact that the clarinet-like resonator does not have resonances at these frequencies; this phenomenon, which also occurs in real clarinets [1], is related to harmonic generation by the non-linear mechanism. Under the same conditions, Figure 2(b) shows the appearance of the first period doubling, which is obtained by increasing the gain in the reaction loop. Successive period doublings were observed in a similar way. Figure 2(c) shows the occurrence of acoustical chaos. Figure 3 was obtained with our set-up; it shows a period tripling phenomenon, observed with a real clarinet as a resonator. This "periodicity window" [11] occurs, as theory predicts [12], inside the chaotic domain. The authors of reference [5] did not report any period tripling [13]; here the phenomenon is visible on the three folds of the upper part of the attractor, as well as in its tail.

4. REPRESENTATION OF RECORDER AND MULTIPHONIC SOUNDS

The natural main control parameter of a recorder is the blowing pressure P. With a regularized source of compressed air ($0{\cdot}1\text{ mb} < P < 2000\text{ mb}$), it is extremely easy to artificially sound the instrument. When increasing P from zero after going beyond a certain threshold value, one first obtains a "normal" periodic oscillation, then a transition