Although our apparatus for producing compression is more complicated at the bottom end than the tension apparatus of Shoenberg and Watts (1967) or Perz and Hum (1971), we felt that this was more than compensated for by being able to dispense with the difficulties of having to solder, glue or clamp our specimens in position.

2.3. Specimens

The specimens used were right cylinders approximately 2 mm in diameter and between 4 mm and 6 mm in length. For our compression experiments it is obvious that we require the ends of the specimens to be flat, parallel to each other and to $\{0001\}$ and that the long axis be parallel to $\langle 0001 \rangle$. The following procedure was followed to obtain these requirements.

The zinc or cadmium started as a large roughly cylindrical single crystal ingot about 25 mm in diameter. Using x rays for orientation determination, a spark erosion machine was used to cut from the ingot a slice whose plane was within a few degrees of $\{0001\}$, and whose thickness was of order 5 mm.

The next step was to spark plane one face of the slice to be exactly parallel to $\{0001\}$. This was done by mounting the rough slice on an adjustable jig in which it was first x rayed and then planed on the spark erosion machine. The jig was designed to be mountable on both the x ray machine and the spark machine and was itself accurately machined so that the axis of rotation of the spark wheel would be exactly parallel to the axis of the x ray beam when it was transferred from one device to the other. Therefore, it was only necessary to adjust the movable part of the jig until the $\{0001\}$ back reflection Laué spot was in the centre of the x ray picture and then transfer the jig to the spark machine where the face was planed.

In order to plane the second face parallel to the first, the slice was turned over and fixed to a plane surface which had itself been planed parallel to the planing wheel. The second face of the slice was then planed, with the slice in this position.

Cylindrical specimens were cut from the slice with a suitably sized tube cutter in the place of the planing wheel. On each cut the tube cutter was stopped just before it reached the bottom of the disc. When a sufficient number were nearly cut out in this way, the slice was turned over again, glued down and planed off until the specimens were separated from the slice. We adopted this rather compncated method for finally separating the specimens from the slice because if the tube cutter were allowed to cut right through then in the final stages the specimens were liable to tip over and be ruined.

2.4. de Haas–van Ælphen detection system

The de Haas–van Alphen oscillations were detected using a conventional low frequency AC field modulation system based on the radio frequency technique of Shoenberg and Stiles (1964). The modulation frequency was usually about 230 Hz, although this was sometimes increased to about 1 kHz to improve signal to noise ratio.

The magnetic field was produced by a superconducting solenoidal magnet with a maximum field of 6 T. The homogeneity quoted by the manufacturers, but not checked, was better than 3 parts in 10^4 over the central centimetre sphere.

The de Haas–van Alphen oscillations were plotted out against magnetic field on an X–Y recorder as shown in figure 3. Because it is difficult to measure the magnetic field directly, the voltage we used to produce the X displacement was obtained from across a resistor placed in series with the magnet current supply. Although this was an easy and convenient thing to do, it suffered from the disadvantage that it would have created experimental errors if there had been any hysteresis in the relation between magnetic field in the solenoid and its energizing current. However, we took precautions in connection with this which are described in §2.5.

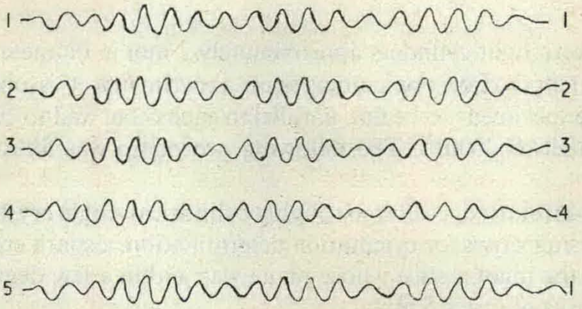

Figure 3. A series of recordings of the α oscillations in zinc with various applied compressional forces. The numbers on the left give the order in which the recordings were made, and the numbers on the right the compressional force in kg weight. All recordings were made with B increasing (left to right) from about 2·7 T to 3·0 T. The amplitude modulation is due to beating with the weaker β oscillations.

We inserted a field back off voltage into the X displacement input of the recorder so that we could expand relatively small variations of magnetic field in order to examine the oscillations in detail.

2.5. Experimental procedure

Initially, setting up adjustments were made to the detection system to maximize the de Haas–van Alphen signal to noise ratio which was further improved by pumping the liquid helium to about 1·2 K.

The position of the specimen holder was then progressively changed until the specimen was in the centre of the magnetic field. During this process the position was monitored by measuring the amplitude of the signal as the specimen holder was moved along the magnet axis in steps of approximately 1 mm. Accuracy in this adjustment is potentially important since the application of tension to the pull rod (producing compression of the specimen) will slightly shorten the whole specimen holder and thereby raise the specimen in the field. Calculation suggests that the spurious change in phase thus produced would be negligible provided the specimen was within a few mm of the field centre to start with. This restriction would have been more severe if we had studied higher de Haas–van Alphen frequencies.

No further adjustments were made and the change of phase with stress was measured as follows. The procedure was to sweep B over a suitable range and plot out a number of oscillations, say about 20, with a very small compression ($T_0 \sim \frac{1}{2}$ kg weight) applied. The field was then swept back to its starting value though two recordings were not usually made with both increasing and decreasing B. The compression T was then increased in steps of say 1 kg weight and at each value of T a recording of the oscillations was made as described above. Finally T was reduced to T_0 and a recording of the oscillations made again. A series of such recordings is shown in figure 3.