the estimated pressures at the peaks are denoted by the figures in units of kbars.

The results shown in the figure are arranged as follows. (i) The magnetic transition, T_c, at $p = 0$ kbar takes place at 200 K [curve (a)]. (ii) In the case of curve (b), the thermal hysteresis associated with the transition is also illustrated, where a dotted curve represents the temperature increasing run. The width of the hysteresis is 4 K. (iii) In the curves from (d) to (h), two peaks at high and low temperatures are clearly discriminated. The temperature increasing run is shown also in (e) and there is a thermal hysteresis at the low temperature peak. (iv) The sensitivity of the output in the measurements of the curves from (d) to (f), and of high temperature peaks in curves from (g) to (i) was about five times as high as that in the measurements of the curves (a) through (c). In other words, the substantial intensity of the high temperature peak in the curve (d) drastically decreased relative to that in curve (c). From (g) to (i), the sensitivity for the low temperature peaks was about two times as high as that for the high temperature peaks. (v) In curve (i), the low-temperature peak at the low temperature side vanishes. The number 15.3 in the left hand corner is the pressure value in kbar at 4.2 K.

Regarding the assignment of the magnetic transitions, there are two points to be considered. One is the thermodynamical order of the transition. With respect to the χ–T curve, the thermal hysteresis and sharp discontinuity at the peak were regarded as indication of a first-order transition. In this respect, the transitions observed in curves (a), (b) and (c), and those at lower temperatures in (d) through (h) have the characteristics of the first order transitions; in addition, they display a thermal hysteresis which is not shown in fig. 2. On the other hand, the transition at high temperature which appear in curves from (d) to (i) are of second order, judging from the peak shape and the experimental fact that hysteresis phenomena were not observed. Another point to be considered will be described in section 3.3.

3.2. Resistivity measurement

The data on the electrical resistivity under various pressures which are complementary to the susceptibility data are given in fig. 3. The lowest curve indicates the result at $p = 0$ kbar and the pressure increases in an ascending order from the lowest to upper curves. The arrows with appended numbers indicate the locations of transition temperatures, the definition of which will be given below, and the numbers, except those with primes, 4′ and 5′, are also used for the curve number. The pressures at the respective transition temperatures are given in the right hand corner in the figure.

The experimental facts which are obtained from the figure are arranged as follows: (i) in the curve at $p = 0$ kbar, a relatively sharp drop is found at 200 K in the temperature decreasing run and a well-defined thermal hysteresis is also observed. This behaviour in in the ρ–T curve is typical of a first-order transition. The transition temperature, 200 K, defined as a temperature at the beginning of the drop, coincides with the temperature determined by the susceptibility measurement. Therefore, this temperature was taken to be the T_c value at $p = 0$ kbar of the Fe_2P specimen employed. (ii) The situation with respect to the first-order transition in curve 1 is the same in curves 2 through 7, where the hysteresis widths become increasingly large. The definition of transition temperatures is the same as in curve 1. (iii) A small but recognizably new bend appears on the higher temperature side, 4′, in curve 4. This bend may correspond to another transition, and the transition temperature defined by the bend and pressure at the bend were 152 K and 9.2 kbar, respectively. The situation regarding the bend is the same in curves 5, 6 and 7, although the curves around the bends are not shown for the latter two cases. (iv) At 17.3 kbar (curve 8), the bend occurs at 135 K, but by 16.9 kbar the first-order transition could not be detected down to 10 K. Regarding the bends observed, the transition at the bend should be of second order, since there is no hysteresis. (v) With respect to the drop in the temperature decreasing run, it should be mentioned that the sharpness of the drop is rather weak in curve 3, but the drops are very sharp in curves from 4 to 7.

Furthermore, the appearance of two peaks in χ–T curves in fig. 2 presumably corresponds to the appearance of the very sharp drop and the bend in ρ–T curves in fig. 3. On this basis, the order of the high- and low-temperature phase transitions in χ and ρ have been assigned consistently. As a whole, the resistivity measurement is more appropriate for the confirmation of the first-order transition as well as for the determination of the transition temperature. On the other hand, the suscpetibility measurement is better for the determination of the second-order transition temperature.

3.3. Pressure-temperature magnetic phase diagram

The transition temperatures determined in figs. 2 and 3 are plotted in fig. 4 as a pressure–temperature magnetic phase diagram. The closed and open symbols stand for the results obtained from the susceptibility and resistivity measurements, respectively. The circles and squares are the first- and second-order transitions, respectively.

Another point to be considered with respect to the magnetic transition is the assignment of the magnetic phases of the three regions, I, II and III in fig. 4. It was made on the basis of the following considerations. Region I: since Fe_2P at atmospheric pressure is ferromagnetic at temperatures below T_c, region I should be ferromagnetic, and all the first-order transition temperatures, therefore, are designated as T_c's.

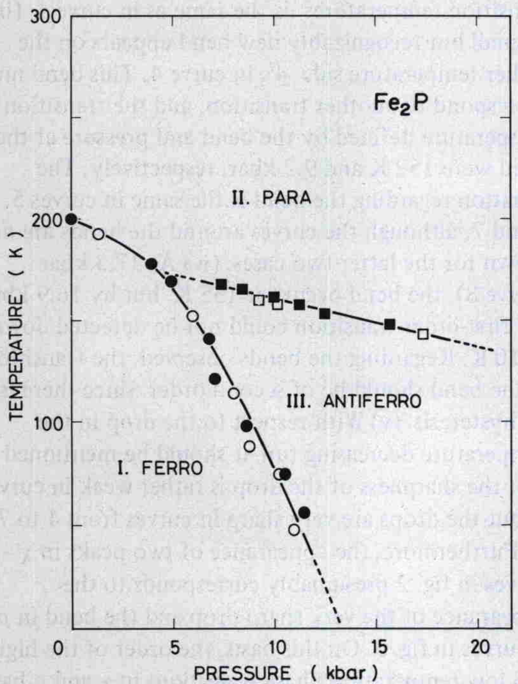

Fig. 4. Pressure–temperature magnetic phase diagram for Fe_2P. ● and ■, susceptibility data; ○ and □, resistivity data.

Region II: Region II should be paramagnetic. Region III: this region, which has been clarified in the present work, is a pressure-induced phase. [G] has suggested a pressure-induced transition to a metamagnetic state on the basis of their results of the dependence of pressure on T_c up to 11 kbar and have estimated the critical pressure, at which the ferromagnetism vanishes at 0 K, as about 13 kbar. [L] has thoroughly investigated the effect on non-stoichiometry by observing the x-dependence of T_c of $Fe_{2-x}P$ $(0 < x \leqslant 0.06)$, and assumed that the magnetic states for $x > 0.04$ is metamagnetic. Furthermore, they took notice of the similarity of the effect of non-stoichiometry to the pressure effect obtained by [G], from the standpoint of the volume contraction due to the introduced vacancies. Fruchart et al. [3] have found in the system $(Fe_{1-x}Mn_x)_2P$ that a very small substitution of manganese into Fe_2P may induce the metamagnetism. Also, the magnetic phase diagram for $0 < x \leqslant 0.05$ obtained by the present authors et al. [8] has established the existence of an antiferromagnetic phase bounded by T_c and T_N (Néel temperature) lines. The magnetic phase diagram seems to be analogous to fig. 4, although the abscissa is not pressure p, but manganese concentration x. Under these circumstances, we might suggest that region III is antiferromagnetic and the second-order phase transition tempertures are therefore T_N's. To establish definitively region III is antiferromagnetic, measurements of the magnetization and of neutron diffraction under pressure should be made, and the former measurement is now in progress.

On the basis of the above-mentioned assignment, the important results in fig. 4 are summarized as follows. (i) When the pressure is larger than about 5 kbar, the rate of decrease in T_c becomes larger and the decrease tends to be rather linear, indicating that the critical pressure at 0 K is about 13 kbar by extrapolating the T_c versus pressure curve. This value of critical pressure is not inconsistent with that suggested by [G]. The initial gradient of the curve at $p = 0$ kbar, $\Delta T_c/\Delta p$, was defined in the present work as the gradient of a line connecting T_c values at $p = 0$ and 1.3 kbar, and it was about -5.4 K kbar^{-1}. [F] also have measured T_c under hydrostatic pressure up to 6 kbar. The data $\Delta T_c/\Delta p$ reported by [F] and [G] are -3.46 and about -4 K kbar^{-1} respectively for