

more slowly with magnetic field than at helium temperatures.

Non-Ohmic behavior of sample 7B was observed at helium temperatures and at pressures up to 4 kbar. This could be seen on  $I$ - $V$  plots at various magnetic fields. But more features can be seen on the  $V$ - $B$  curves shown in Fig. 10, which is a photograph of the direct recorder traces of the voltage drop (or electric field) along the sample as a function of magnetic field at various constant currents. At currents below 1 mA the resistivity rises smoothly with magnetic field. At higher currents it rises more slowly and in particular shows a slight "knee" or discontinuity in slope. In Fig. 10 the positions of the knees are seen to fall on a straight line on the plot of electric field vs magnetic field. The top portion of Fig. 10 shows a plot of the derivative vs magnetic field of the 2-mA curve. In addition to the "knee" other structure with a complicated current dependence is observed. At 1 mA no corresponding structure (or knee) in the derivative could be detected. At present we do not understand this behavior.

#### ANALYSIS USING $\vec{k}\cdot\vec{p}$ MODEL

The observed variation of the electron concentration with pressure  $P$  results from the pressure dependence of the energy gap  $E_g$ . We have fitted the  $n$ -vs- $P$  curve for sample 7B at 77 °K (Fig. 5) by assuming a linear pressure dependence:

$$E_g = E_0 + \alpha P,$$

where  $E_0$  is the energy gap at zero pressure,  $\alpha$  the pressure coefficient of  $E_g$ , and  $P$  the applied pressure. A similar method has been used by Schmit<sup>28</sup> to calculate the intrinsic concentration in  $\text{Hg}_{1-x}\text{Cd}_x\text{Te}$  alloys.

The concentration of ionized acceptors,  $N'_A$ , was assumed to be independent of pressure, and equal to  $1.5 \times 10^{16} \text{ cm}^{-3}$ , the value of  $p$  determined from the limiting value of  $R$  at high pressure. The position of the Fermi level was adjusted at each pressure until the calculated values of  $n$  and  $p$  satisfied the condition

$$p - n = N'_A.$$

The electron concentration was obtained by numerical integration of an expression given by Harman and Strauss<sup>29</sup> which is based on the Kane model and includes the effects of nonparabolicity and statistical degeneracy. A value of  $8.4 \times 10^{-3} \text{ eV cm}$  was used for the Kane matrix element. The valence band was assumed to be parabolic with an effective mass  $m_v^*$  and the hole concentration was obtained using the standard density-of-states expression. The calculations were made for masses between  $0.3m_0$  and  $0.7m_0$ , the range of values reported for  $m_v^*$  in  $\text{Hg}_{1-x}\text{Cd}_x\text{Te}$  and  $\text{HgTe}$ .<sup>5-11</sup>

The values of  $E_0$  and  $\alpha$  were adjusted to fit the calculated curve of  $n$  vs  $P$  to the experimental curve. The curve obtained for the two extreme values of  $m_v^*$  are shown in Fig. 5. The pressure coefficient in both cases is  $7.0 \times 10^{-3} \text{ eV/kbar}$  and the values for  $E_0$  are +2 and -8 meV for  $m_v^*$  of  $0.7m_0$  and  $0.3m_0$ , respectively. These may be compared with values of +11.6 and -15 meV obtained for  $x=0.15$  from empirical expressions for  $E_g(x, T)$  given by Wiley and Dexter<sup>8</sup> and Scott,<sup>30</sup> respectively. The behavior of the electron mobility shown in Fig. 6 is consistent with  $E_g=0$  near  $P=0$ . The failure to fit the experimental  $n$ -vs- $P$  data well at low pressures may be due to an incorrect choice of  $m_v^*$  or to the invalidity of the assumption that  $N'_A$  is constant. The latter will be strictly true only if the acceptor ionization energy is small relative to  $kT$ , and the analysis below indicates that the acceptor energy in this sample is comparable with  $kT$  at 77 °K. At higher pressure where  $N'_A \gg n$ , the slope in Fig. 5 is sensitive to the pressure coefficient, and relatively insensitive to the other parameters. The fitting at 77 °K should therefore yield a reliable value for  $\alpha$ .

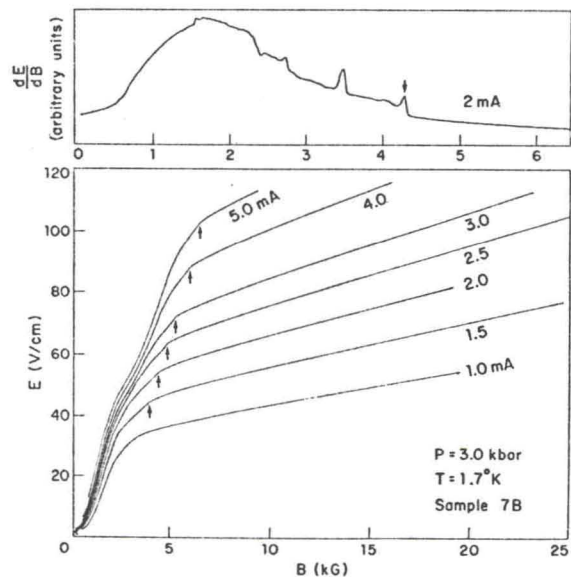


FIG. 10. Photograph of the direct recorder traces of the voltage drop (or electric field) along sample 7B as a function of magnetic field for several currents. (The sample cross-sectional area is  $2.5 \times 10^{-3} \text{ cm}^2$ .) The sample is non-Ohmic, since for  $B > 5 \text{ kG}$ ,  $E$  is not proportional to the current. In addition, structure is observed in the region  $1.5 < B < 6 \text{ kG}$  for sample currents greater than 1 mA. This structure is shown on an expanded scale by the derivative curve in the upper part of the figure. "Knees" appear in the curves at fields (4.25 kG on the 2-mA curve) which mark a disappearance of the structure. These "knees" marked by arrows are seen to fall on a straight line on the  $E$ -vs- $B$  plot.