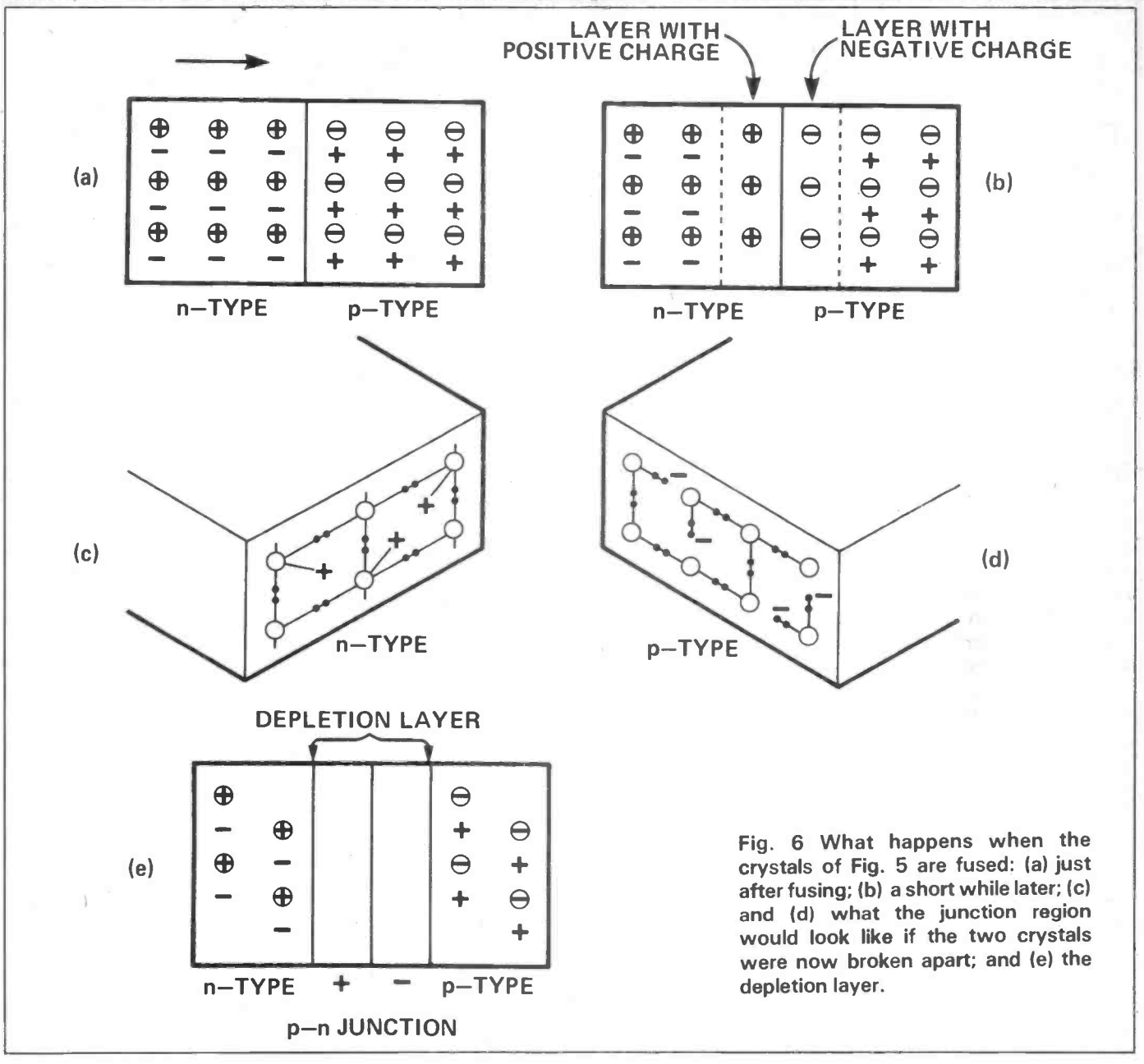

Fig. 6 What happens when the crystals of Fig. 5 are fused: (a) just after fusing; (b) a short while later; (c) and (d) what the junction region would look like if the two crystals were now broken apart; and (e) the depletion layer.

considering a tug-of-war team which isn't moving either way, i.e. at stalemate, so one team cheats by putting on an extra man, with the result that the 'short-staffed' team is pulled towards the overmanned team.

Connecting a battery positive to p-side across a junction diode (**Fig. 7a**) results in two reactions within the diode. One is that more free electrons are pulled out of the p-side (or you can think of it as more holes being made in the p-side), and the second is that additional free electrons are infused into the n-side. If the battery voltage is enough to overcome the space charge, then the electrons will be propelled into the n-side and pulled through the junction. And, if the pressure (from the battery voltage) is kept up, then, after an initial slow start, a steady current will flow through the diode.

Having the battery connected with its positive to the p-side of the diode is said to **forward bias** the diode. The circuit diagram for this way of connecting the diode to the battery is shown again in **Fig. 7(b)**, which introduces the circuit symbol for the diode. **Fig. 7(c)** shows an alternative symbol for the diode; in both cases, the 'arrowhead' of the symbol points in the direction of the conventional current (and also hole) flow.

For a steady current to flow through a forward biased diode, the (voltage) bias applied *must* be sufficient to overcome the space charge of the diode. The space charge for a germanium diode is about 0.25V and for a silicon diode about 0.65V. Hence the forward bias voltage needed to overcome the space charge and so to give the carriers sufficient forward velocity to get into the opposite type of material is about 0.15 - 0.2V for germanium and about 0.6V for silicon. The reason the required forward bias is actually *less* than the space charge is because the carriers only need to get half-way through the depletion layer to 'cross over' into the opposite type of material.

For lower forward bias voltages, a small current will actually flow across the junction but this current is *very* much less than the current that can flow when the space charge is overcome. When the forward bias voltage just reaches the space charge voltage value there is a rapid (exponential to be technical) increase in current flow.