GUNN DOMAIN :

- When a d.c. bias of a value equal to or more than corresponding to threshold field is applied to a Gunn diode the charge densities and the electric field within the sample become nonuniform. Due to this reason domains (bunch of electrons) are created i.e., electrons in some region of the sample experience transfer first than the rest of the sample. The reason is as follows:
- It is reasonable to accept that the density of doping material is not completely uniform throughout the sample GaAs. So it is possible that there may be a region, perhaps somewhere near the negative end, where such an impurity concentration is less than average. In such a region there will be fewer free electrons than in other areas and therefore this region is less conductive than the other. As a result, the field in this area will be greater than anywhere else in the sample i.e., the potential at this region will be greater than average potential. When the applied potential is increased, this region will be the first to have a voltage across it large enough to induce transfer of electrons to the higher energy band. Infact, such a region will than become a NEGATIVE RESISTANCE DOMAIN.

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There may be another possibility of the non uniformity in charge density and electric field. This is due to thermal fluctuations in the carrier density. The fluctuations in the carrier density creates a localised excess of electrons. The electric field near the excess of electrons is composed of both the applied field E_m and the field of charges. This is visualised in Fig. 7. It is obvious from Fig. 7 that the net electric field on the

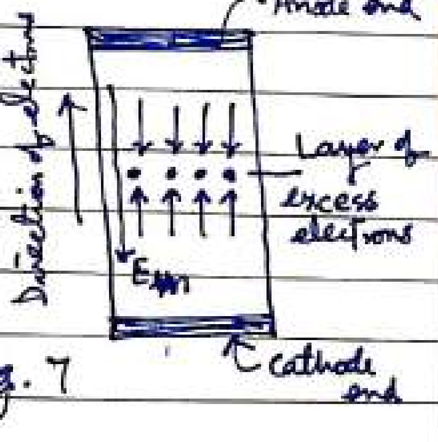

Fig. 7

anode side exceeds threshold, the domain move with lesser velocity. This creates a slight excess of electrons in that location and a slight dificiency of electrons immediately ahead. The region of excess and deficient electrons from a dipole layer. The electric field inside the dipole layer is higher than anywhere else. The electric field outside the dipole starts dropping as a result of constant applied field. As the dipole drifts along, more electrons in the vicinity will transfer to upper constant applied field. This continues until the electric field outside the dipole region is depressed below the threshold value of the field and the dipole is collected at the anode. Upon collection, the field in the sample jumps to the original value. Now the next formation of the domain begins as soon as the field value exceeds the threshold value.

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The domain is quite capable of traveling and may be thought of as a low conductivity, high transfer region, corresponding to a negative pulse of voltage. When it arrive at the positive end of a slice, a pulse is received by the associated tank circuit and shocks into oscillations. Infact these pulses are responsible for the oscillation in the Gunn diode, rather than the negative resistance. It is seen that only one domain, or pulse, is formed per cycle of RF oscillations, so that energy is received by the tank circuit in correct phase to permit oscillation to continue.

L.S.A. MODE AND DIODE

(L.S.A. = Limited Space-Charge Accumulation)

Repeated

The term diode is misnomer for Gunn diode because neither there is a junction nor the rectification. This is called diode simply because it has two terminals.

Repeated

The Gunn devices have a number of names as the transferred electron device (TED); transferred electron oscillator (TEO), bulk effect diode (BED), bulk effect oscillator (BEO) and bulk GaAs oscillator (BGAO). In LSA mode the domain is allowed to form at all. The frequency and r.f. voltage are so chosen that the domain is not sufficient time to form before it is extinguished.

The basic construction of LSA diode is shown in Fig. 8. The construction is similar to a Gunn diode with difference that the size of active region is much larger in this case. The larger size of the active region permits higher power dissipation which causes higher power output and higher power frequencies. As the domains are suppressed, negative resistance operation takes place. This is relatively independent of transit time i.e., the device length. The voltage across the larger diode can be increased considerably for the same current. Thus the power output is increased significantly

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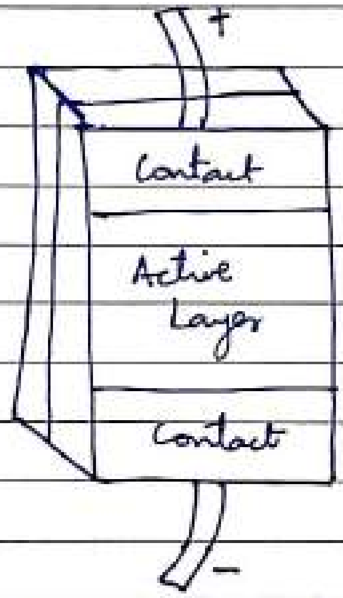

Fig. 8 Basic construction of LSA diode.

Following are steps used to prevent the formation of domain.

① As shown in Fig. 9, the applied voltage is well in excess of the threshold value. This bias together with the external resistance is so arranged that the oscillating voltage exceeds past the negative resistance region. Thus any domain formation will be dissipated.

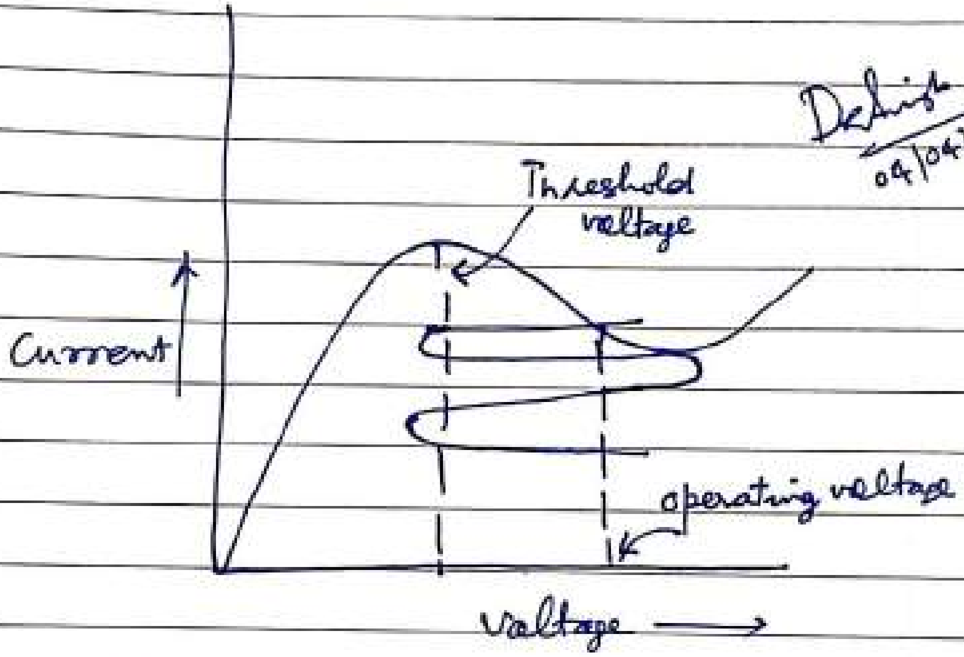

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Fig. 9 V-I characteristics of LSA diode

② The resonant frequency (r.f.) of the cavity is made three to twenty times the required value for domain operation. Now the r.f. cycle is too fast to permit the domain formation anywhere.

③ The domain formation can be also prevented by. Carefully chosing the ratio of doping level to the operating frequency.

(P.T.O.)

ADVANTAGES OF L.S.A. MODE

LSA mode has the following advantages :

(1.) High efficiency is obtained since most of the devices exhibit negative differential conductance.

(2.) Since the domains are not formed, high operating voltage is permitted without causing avalanche breakdown. This suggests high power operation.

(3.) This mode may be utilised for pulsed oscillations at highest frequencies.

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