Goldman, Tsui, and Cunningham Reply: The data presented in Fig. 1 of the preceding Comment[1] display *extrinsic* bistability; the statement that "The hysteresis occurs because of the oscillations"[1] is not substantiated and is, in our opinion, erroneous. Indeed, although Sollner does not provide any information about his sample, it is quite clear that the current peak occurs at about 0.2 or 0.3 V across the double-barrier region of the device.[2] Therefore, the extra 0.7 or 0.8 V of the total bias drops across a series resistance (made up of the resistance of the electrodes, the substrate, the contacts, and the external wires). From the data of Fig. 1 in Ref. 1 we estimate the series resistance to be $\simeq 100\ \Omega$ [(0.7 V)/(7 mA)]. This series resistance in Sollner's sample leads to *extrinsic* bistability; this point has been discussed in the text and in Refs. 11 and 12 of our Letter.[3]

Moreover, Sollner's argument is flawed logically since the mere presence of an oscillation does not in itself exclude intrinsic bistability in a double-barrier resonant-tunneling structure (DBRTS), nor does an oscillation necessarily preclude the possibility of observation of intrinsic bistability (if the amplitude is small enough). On the other hand, it has been argued recently[4] that an overdamped bistable system can display a negative differential resistance (NDR) region, rather than bistability, in its response. This might be the case with Sollner's NDR-displaying "true" I-V curves.[5]

We would like to use this opportunity to describe an experimental detail, which we have discussed in private conversations and in talks, but not in a publication. It is an additional Schottky-barrier capacitor integrated with the DBRTS device as shown in Fig. 1. This capacitor is in an intimate contact with the DBRTS device and allows us to decrease the maximum possible frequency of an oscillation, f_{max}. For the device of Ref. 3 we estimate that the RC time constant limits F_{max} to $\simeq 4$ GHz without and $\simeq 200$ MHz with the Schottky capacitor. An external 10-nF capacitor decreases f_{max} further so that the oscillation does not occur.[3] Of course, the Schottky-contact leakage current has to be negligibly small in the bias range of interest.

Also, we are compelled to point out that Sollner's Comment contains certain misstatements of our work which include, but are not limited to, the following:

(1) We never argued that "... putting a capacitor across the terminals removed the possibility of oscillation."[1] We did argue, however, that "... we can maintain V constant ... by connecting a capacitor ...,"[3] i.e., it is *possible* to suppress oscillations using a capacitor, as we actually were able to do.

(2) Sollner writes that the intrinsic bistability in DBRTS "... has been predicted theoretically ..."[1] by others, whereas in reality, our work had been completed, written up, and submitted for publication before 15 December 1986.[3,6]

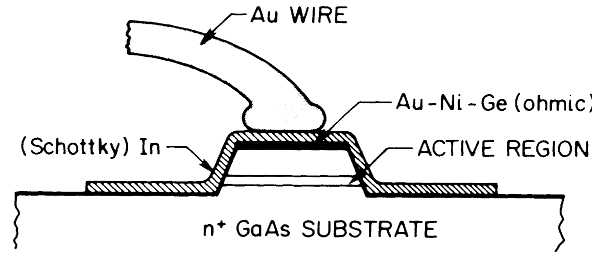

FIG. 1. Schematic (not to scale) diagram of the DBRTS device with an integrated Schottky capacitor. The Au-Ni-Ge film is alloyed to form an Ohmic contact; the second Ohmic contact is made to the n^+ GaAs substrate. The In (or Au, etc.) electrode is not alloyed and therefore forms a Schottky contact to GaAs (area 10 to 100 times the area of the DBRTS device) with (often) a negligibly small leakage current in the bias range $-3\ V < V < 0.8$ V.

In conclusion, we note that the intrinsic bistability and the buildup of negative space-charge in the well in DBRTS has been confirmed in independent experiments.[7]

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Received 20 May 1987
PACS numbers: 73.40.Gk, 72.20.−i, 79.80.+w

[1]T. C. L. G. Sollner, preceding Comment [Phys. Rev. Lett. **59**, 1622 (1987)].

[2]See, e.g., Refs. 1–5 of V. J. Goldman, D. C. Tsui, and J. E. Cunningham, Phys. Rev. Lett. **58**, 1256 (1987).

[3]Goldman, Tsui, and Cunningham, Ref. 2.

[4]C. M. Dow, C. J. Lambert, R. Mannella, and P. V. E. McClintock, Phys. Rev. Lett. **59**, 6 (1987).

[5]T. C. L. G. Sollner *et al.*, Appl. Phys. Lett. **45**, 1319 (1984).

[6]V. J. Goldman, D. C. Tsui, and J. E. Cunningham, Bull. Am. Phys. Soc. **32**, 833 (1987), and Phys. Rev. B **35**, 9387 (1987).

[7]C. A. Payling *et al.*, in Proceedings of the Third International Conference on Modulated Semiconductor Structures, Montpellier, France, July 1987 (to be published).

