DOUBLE-LAYER PHENOMENA IN THE E_s REGION*

By J. A. THOMAS†

At Brisbane, ionospheric records are frequently made which show the simultaneous presence of two types of E_s ionization, one at a greater virtual range than the other; these have been classified by McNicol and Gipps (1951) as " sequential " type (E_{ss}), and " constant-height " type (E_{sc}), respectively. Such records occur most frequently in the late afternoon and early evening,

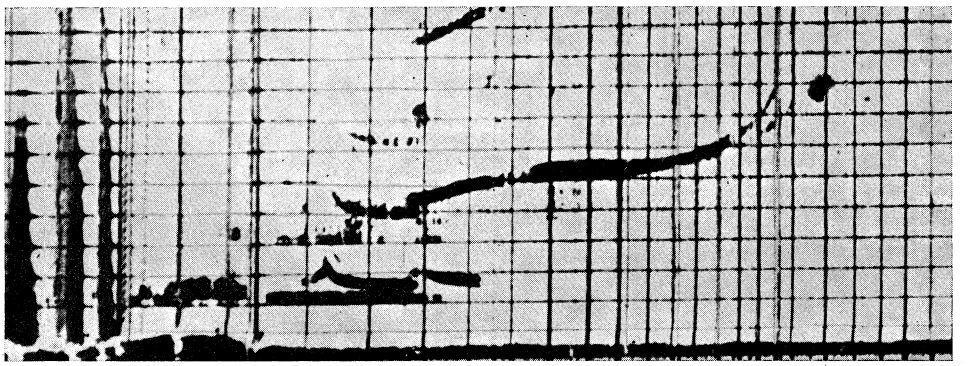

Fig. 1.—$P'f$ record showing echoes from two different E_s regions at 100 and 120 km.

particularly in summer, when E_{ss} is in its last stages and E_{sc} is building up to its maximum intensity (Thomas 1956). Very often such " double-layer " records will continue for an hour or longer, until one of the traces (usually the upper one) either simply fades out with the general night-time decrease in ionization,

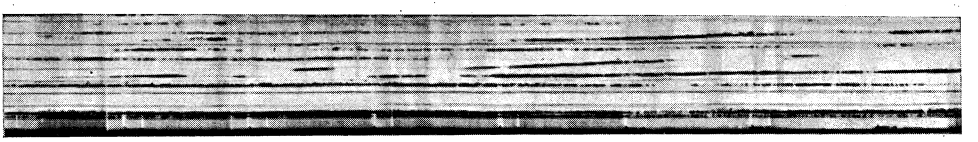

Fig. 2.—$P't$ record (2·28 Mc/s) showing a double E_s layer reflection.

or increases in range as the region moves to one side. Examples of this phenomenon as it occurs on $P'f$ and $P't$ (2·28 Mc/s) records, are shown in Figures 1 and 2.

There are a few occasions when, in addition to the two traces due to the double layer, there appears a " stack " of echo traces, each separated by the

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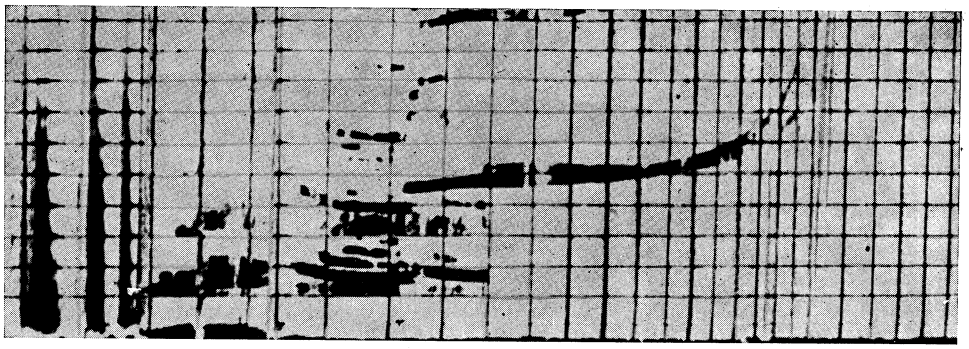

Fig. 3.—*P'f* record showing multiple-hop echoes arising from a double E_s layer.

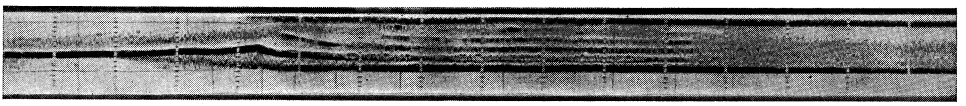

Fig. 4.—*P't* record showing a " stack " of multiple-hop echoes arising from a double E_s layer.

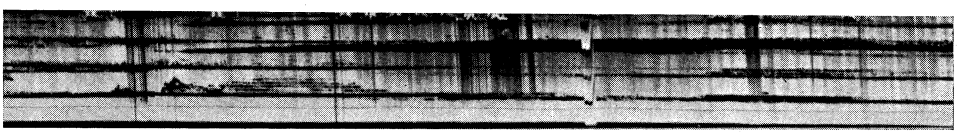

Fig. 5.—*P't* record showing a " stack " with a curious structure brought about by the movement of slightly tilted regions of a double layer.

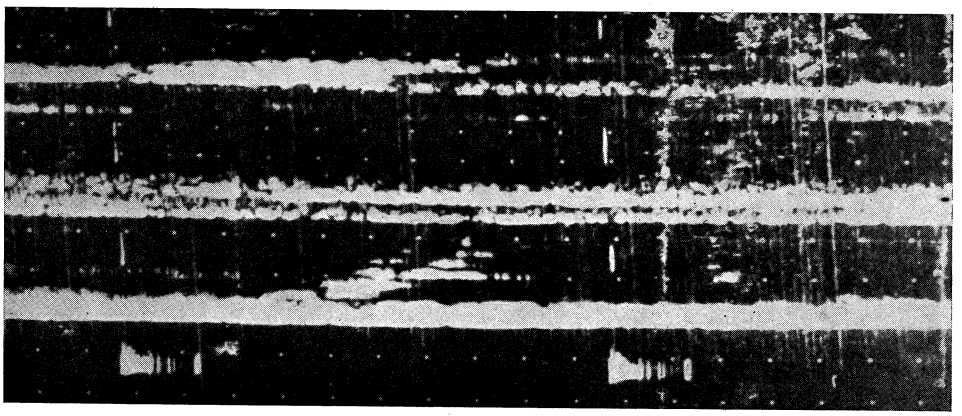

Fig. 6.—*P't* record showing a " stack " structure due to movement of a tilted region of a double layer.

spacing of the base layers. Figures 3–6 show some examples of such double-layer stacks.

Such echoes can be explained on the basis of multiple hops between the two layers. The structure shown in Figure 4 needs no further explanation; the curious patterns of Figures 5 and 6, however, need further investigation, and an explanation has been devised along the lines given by Baird (1954) in explaining the production of abnormal high multiple F echoes.

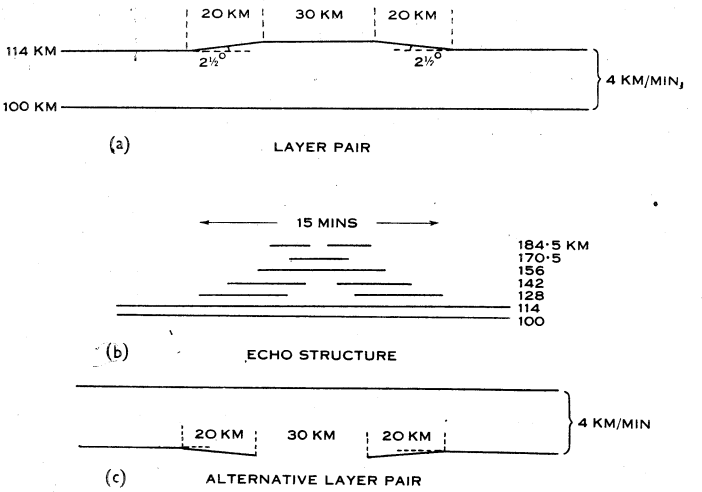

Fig. 7.—Structure of hypothetical layer pair, and the echoes to which such a layer pair would give rise.

If we suppose one of the layers to be substantially flat and the other to have regions of small slope (Fig. 7 (*a*)), then horizontal movement of the sloping layer (or both) will give rise to multi-hop echoes of ranges similar to those shown in Figure 5. With a horizontal speed of 4 km/min such a layer system will give rise to the traces sketched in Figure 7 (*b*). This echo structure differs from that in Figure 5, in that in the actual record the lowermost trace is absent for part

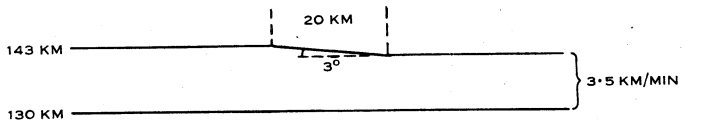

Fig. 8.—Hypothetical layer pair which gives an echo structure very similar to that of Figure 6.

of the time; this can well be explained if the upper side of the layer is a better reflector than the lower side, which is not uncommon (Thomas 1956). An alternative and more probable explanation is shown in Figure 7 (*c*); such a layer pair gives the correct echo structure including the gap in the lowermost trace.

The structure of Figure 6 may be explained by the hypothesis of the movement of a single sloping portion of one of the layers as sketched in Figure 8.

It appears, then, that sloping regions can exist in moving E_s layers. If a layer is regarded as made up of an aggregate of disk-like clouds (Thomas and Burke 1956), then it is logical to expect small sloping regions of the order of those envisaged in the above discussion.

On the other hand, the larger sloping regions necessary to produce high multiple E_s patterns similar to those found for F echoes, are not very likely to occur because of the limited size of E_s clouds. An examination of the records taken over two years revealed only one such pattern and even that was a doubtful example.

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References

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