

skilled in the art that only slight variations as to said differences, for example caused by corrosion spots, electrical perturbation, mechanical damage, or circuitry tuning, will result in substantial casing current errors. Consequently obtaining reliable leakage current determinations is very difficult.

Thus it is a main object of the present invention to detect leakage currents more accurately.

It is a further object of the present invention to eliminate the contribution of the casing currents in the leakage current detection as much as possible.

Therefore in accordance with the invention the above system further comprises

- a ~~first~~ pair of current electrodes, ~~A, B~~, connected with said supply means and said control means, adapted to be electrically connected to the casing within said borehole at different heights in axial direction of said borehole, and, when connected, defining an intermediate casing part, for supplying an electrical current to said casing and providing a casing current through said casing part between said electrodes, and positioned nearby one of the ends of the borehole, and
- a ~~second~~ pair of voltage electrodes, ~~M, N~~, for detecting voltages provided by leakage currents leaking from the casing into the formation, said ~~second~~ pair of ^{voltage} electrodes being adapted to be arranged in axial direction of the borehole above or below said ~~first~~ pair of current electrodes between said intermediate casing part and the other end of the borehole;

In a further embodiment of the present invention at least one electrode of the ~~second~~ pair of ^{voltage} electrodes is adapted to be electrically connected to the casing within said borehole. Furthermore, if both electrodes of said ~~second~~ pair ^{of voltage electrodes} are electrically connected to said casing, one electrode of said ~~second~~ pair of ^{voltage} electrodes, ~~B~~, is

Wherein the pair of current electrodes includes a current electrode nearest to said other end of the borehole, and ~~that~~ said pair of voltage electrodes is adapted to be arranged between said other end of the borehole and said current electrode nearest to said other end of the borehole.

arranged in axial direction of the borehole adjacent to said ~~first~~ pair of ^{current} electrodes and the other at a substantial distance away from said one electrode.

In particular said other electrode ~~is~~ is arranged down below in the borehole nearby the casing shoe, or said other electrode ~~is~~ is arranged at the top of the borehole nearby the earth's surface.

In yet a further embodiment of the present invention said ~~second~~ pair of ^{voltage} electrodes is adapted to be located at the earth's surface.

In a preferred embodiment of the present invention at least a third voltage electrode, adapted to be electrically connected to the casing within said borehole as a calibration electrode, ~~is~~ is arranged adjacent to said ~~first~~ pair ^{of voltage electrodes} and at the other side of said ~~first~~ pair of ^{voltage} electrodes compared to said ~~second~~ pair ^{of current} electrodes.

In a further preferred embodiment of the present invention at least one additional voltage electrode is arranged, located substantially between said ~~second~~ pair of voltage electrodes.

By using the electrical logging system of the present invention every current travelling through the casing outside said intermediate casing part is only originating from leakage currents which start predominantly from the casing outside said intermediate casing part from the casing part at one side of said intermediate casing part, leak into the formation and return through the casing at the other side of said intermediate casing part. Thus the ^{pair of} voltage electrodes ~~of~~ ~~the second pair~~ only detect leakage currents either in the formation or through the casing, dependant on the location of said second pair voltage electrodes. Advantageously casing currents are fully eliminated when detecting such leakage currents, thus allowing accurate determination of formation resistivities.

C L A I M S

1. An electrical logging system for determining the electrical resistivity of a subsurface formation through a cased borehole, the system comprising,
 - voltage and current supply means,
 - voltage and current control means, and
 - electrode support means,the system further comprising,
 - a ~~first~~ pair of current electrodes, ~~A, B~~, connected with said supply means and said control means, adapted to be electrically connected to the casing within said borehole at different heights in axial direction of said borehole, and, when connected, defining an intermediate casing part, for supplying an electrical current to said casing and providing a casing current through said casing part between said electrodes, and positioned nearby one of the ends of the borehole,
 - a ~~second~~ pair of voltage electrodes, ~~M, N~~, for detecting voltages provided by leakage currents leaking from the casing into the formation, said ~~second~~ pair of ^{voltage} electrodes being adapted to be arranged in axial direction of the borehole above or below said ~~first~~ pair of current electrodes between said intermediate casing part and the other end of the borehole, and
 - voltage and current processing means for processing said currents and voltages thereby determining said electrical resistivity.
2. The system as claimed in claim 1, wherein at least one electrode of the ~~second~~ pair of ^{voltage} electrodes is adapted to be electrically connected to the casing within said borehole.
3. The system as claimed in claim 2, wherein, if both

Characterised in that the pair of current electrodes includes a current electrode nearest to said other end of the borehole, and that said pair of voltage electrodes is adapted to be arranged between said other end of the borehole and said current electrode nearest to said other end of the borehole.

electrodes of said ~~second~~ pair ^{of voltage electrodes} are electrically connected to said casing, one electrode of ~~said second~~ ^{slot} pair of voltage electrodes ~~is~~ is arranged in axial direction of the borehole adjacent to ~~said first~~ ^{let} pair of ^{current} electrodes and the other ^{electrode of the pair of voltage electrodes} at a substantial distance away from said one electrode.

4. The system as claimed in claim 3, wherein said other electrode ~~is~~ is arranged down below in the borehole nearby the casing shoe. ^{any one of} ^{1 to}

5. The system as claimed in claim ^{any one of} 3, wherein said other electrode ~~is~~ ^{of the pair of voltage electrodes} is arranged at the top of the borehole nearby the earth's surface.

6. The system as claimed in ~~any one of claims 1 to 5~~ ^{voltage}, wherein said ~~second~~ pair of electrodes is adapted to be located at the earth's surface.

7. The system as claimed in any one of the ^{preceding} ~~claims 1 to 5~~, wherein at least a third voltage electrode, adapted to be electrically connected to the casing within said borehole as a calibration electrode ~~is~~ is arranged adjacent to said ~~first~~ pair and ~~at the other side of said first pair of~~ ^{voltage} electrodes compared to said ~~second pair of~~ electrodes.

~~8. The system as claimed in claim 4, wherein voltage electrodes M and R are arranged symmetrically with regard to the first pair of current electrodes, A, B.~~ ^{any one of} ^{1 to 5}

⑧ 9. The system as claimed in any one of the claims 1 to ~~5~~ ^{including}, wherein ^{for detecting perturbation currents} at least one additional voltage electrode ~~is~~ ^{coupled to said voltage and current processing means and} arranged, located ~~substantially~~ between said ~~second~~ pair of voltage electrodes.

⑨ 10. The system as claimed in claim ~~8~~ ⁹, wherein said additional voltage electrode is adapted to be electrically connected to the casing within said borehole.

⑩ 11. The system as claimed in any one of the ^{preceding} ~~foregoing~~ claims, wherein the ratio of the distance between the

current electrodes, ~~is~~ measured in the borehole direction, and the casing diameter ~~is~~, ranges from 3 to 15.

12. The system as claimed in any one of the foregoing claims, wherein the casing current provided is an AC current, having a frequency up to 20 Hz and an amplitude up to 40 A.