GOVERNMENT OF INDIA, THE PATENT OFFICE
214, ACHARYA JAGADISH BOSE ROAD
CALCUTTA-700017.

Complete Specification No. 163185 dated 30th August, 1985.
Application and Provisional Specification No. 252/Del/85 dated 23rd March, 1985.
Acceptance of the complete specification advertised on 20th August, 1988

International Classification— G01V 3/00, G01n 33/24, G01r 27/00.

"A DIRECT READING FOUR PROBE RESISTIVITY METER".

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH, Rafi Marg, New Delhi-110001, India, an Indian registered body incorporated under the Registration of Societies Act (Act XXI of 1860).

The following specification describes the nature of this invention.

PRICE: TWO RUPEES

This invention is conceived by Holavanahalli Narayana Rao, Venkoba Rao, Yagnanarayana Iyer Mahadeva Iyer, Nerur Sankaranarayanan Rengaswamy, Seshadri Srinivasan, and Ramia Karigovinda Rao Suresh Bapu, all of Central Electrochemical Research Institute, Karaikudi, Tamil Nadu all Indian Citizens and relates to ~~Improvements in or relating to~~ an improved direct reading four probe resistivity meter.

Hitherto it has been proposed that the electrical resistance of an environment like soil or concrete can be measured in situ by using a null balance instrument and four probes/three probes/single probe.

This is open to the objection that:

(i) the measurements based on the null balance instrument are suspectible to subjective error.

(ii) A number of operations are involved making it time consuming.

(iii) Sensitivity is low and it also varies with the resistance values.

iv) The probes are separate from the main instrument resulting in use of long cables.

(v) Though the principle of electrical resistance measurements is known, a direct reading digital instrument with provision for direct display of electrical resistivity is not available.

The main objective of this invention is therefore to obviate these disadvantages by developing a direct readng digital electrical resistivity meter with built-in probes.

The main finding of the invention is that by constructing a spring loaed arrangement of four metal probes of suitable size and shape and of equal interelectrode distance, by passing a known amount of current through the two outer probes and by measuring the potential between the two inner probes and then electrical resistivity, the electrical resistivity of a given environment, concrete in particular can be obtained instantaneously in terms of ohm cm/kiloohm cm. Interference effects from the steel reinforcement grid is avoided by proper placement of the probe on the rainforced concrete surfaces. For measurements in soil, a separate set of four probes is used.

The result is that the electrical resistivity of any environment like concrete and soil can be quickly measured at any time without disturbing the system.

The instrument according to this invention consists of a built in spring loaded four probe unit and electronic circuits for conversion of the current-voltage data in terms of resistance and scaling of the data to display the resistivity in digital panel meter. The schematic block diagram of the meter is shown in figure 1. of the drawings accompanying the specificaition. Block (1) is the square wave generator for supply of (A.C.) current and Block (2) is the constant current source which impresses a constant (AC) current through the two outer probes C_1 and C_2 as shown in block (3). The purpose of the square wave generator is to avoid polarisation effects in the measurements. The potential drop between the two inner probes P_1 and P_2 of block (3) is fed to a commutator shown in block (4) and converted into resistivity

values and displayed in the digital panel meter in block (5). The construction details of the spring loaded built-in probe is shown in fig. 2 of the drawings accompanying the specification. The four probe unit is mounted in a PVC frame (6). Each of the four copper probes C_1, P_1, P_2, C_2 with pointed ends is threaded to a PVC tube connector (7) which is held in aluminium tube (8) and a spring (10) is provided between the aluminium head and PVC tube connector. The pointed end of the copper probe is wrapped with sponge (11) saturated with water for making effective contact with the concrete surface (12). The display unit (13) in which the electronic curcuits are housed is mounted at the top of PVC frame (6). The push button switches (14) for operating the instrument are mounted at the top of the display unit (13). The resistivity is displayed in the digital panel meter (5) as shown in figure 3 of the drawings accompanying the specification. Fig. 3 is the plan view of Fig. 2.

Dated this 21st day of March 1985.

N R Subbaram

(N.R. SUBBARAM)
JOINT ADVISER (PATENTS)
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

163185

THE PATENTS ACT, 1970

COMPLETE SPECIFICATION

(Section—10)

" A DIRECT READING FOUR PROBE RESISTIVITY METER".

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH, Rafi Marg New Delhi-110001, India, an Indian registered body incorporated under the Registration of Societies Act (Act XXI of 1860).

The following specification particularly describes and ascertains the nature of this invention and the manner in which it is to be performed :—

This invention is conceived by Holavanahalli Narayana Rao, Venkoba Rao, Yagnanarayana Iyer Mahadeva Iyer, Nerur Sankaranarayanan Rengaswamy, Seshadri Srinivasan, and Ramia Harigovinda Rao Suresh Bapu, all of Central Electrochemical Research Institute, Karaikudi, Tamil Nadu all Indian Citizens and relates to direct reading four probe resistivity meter.

Hitherto it has been proposed that the electrical resistance of an environment like soil or concrete can be measured in situ by using a null balance instrument and four probes/three probes/single probe.

Resistivity of various media are measured by passing a current through the medium and then measuring the voltage drop across a known distance between two points on the diametionally defined specimen. Resistivity of a specimen is defined as $\rho = AR/l$ where R is the resistace measured, A is the cross sectional area and l is the length of the specimen. Techniques vary depending on various situations. In the case of very low resistivities like that inmetals invariably a four probe technique has necessarily be used since the lead resistances are very high compared to the reistance of the specimen. When the resitance is much high i.e. greater than 100 Ω then other techniques like two an three probe techniques also could be used. In the case of soil resistivity measurements, the probe can be inserted into the soil. In the case of hard materials like metals, concrete etc. the measurements are to be made only on the outer surface. Many occasions when the current flow is due to ionic conduction also, direct current cannot be used to make resistivity measurements.

This is because plarisation effects also play an important role in giving misleadig results. In view of this, invariably alternating currentis used to make resistivity/conductivity of electrolytes/soil/solid ionic conductors etc. Hence resistivity meters available for various applications differ very much depending upon the applications and the specially configured probes and electronics.

For measureent of resistivity of concrete whose resistivity varies from 100 ohm cm to greater than 10^6 ohm cm no equipment is available. Conductivity bridges, soil resistivity bridges are difficult to use in view of the probes not suitable for the purpose The resistivity meter probes available are (1) single probe (2) three probe and four probe. In the single probe the inner conductor separated by an insulator is covered by an outer conductor axially. The A.C. produced by means of a mechanical vibrator is passed through the media when this probe is inserted into the medium. The potential drop across the probe when the current passed divided by the current gives the resistance. In the case of three probes, the current is passed through two outer probes kept in a line. The third probe with respect to one curret probe the potential drop between it and the other probe, when inserted into the medium in line with the two outer current probes. In the commercially available equipments, the probes and the instrument are separate requiring lengthy cables to be used when measuring the resistivity of locations not easily accessible.

None of the commercially available instruments is found to be convenient to use when it comes to measure the resistivity of concrete insitu on the concrete structures. This is because the probes cannot be positioned properly on the surface of concrete. But to get valuable information about the quality of concrete and its deterioration in RCC structures, such an instrument is highly useful.

Further (i) the measurements based on the null balance instrument are suspectible to subjective error.

(ii) A number of operations are involved making it time consuming.

(iii) Sensitivity is low and it also varies with the resistance values.

iv) The probes are separate from the main instrument resulting in use of long cables.

(v) Though the principle of electrical resistance measurements is known, a direct reading digital instrument with provision for direct display of electrical resistivity is not available.

The main objective of this invention is therefore to obviate these disadvantages by developing a direct reading digital electrical resistivity meter with built-in probes.

The main finding of the invention is that by constructing a spring load arrangement of four metal probes of suitable size and shapeand of equal inter electrode distance, by passing a known amount of current through the two outer probes and by measuring the potential between the two inner probes and then

electrical resistivity, the electrical resistivity of a given environment, concrete in particular can be obtained instantaneously in terms of ohm cm/kilo ohmcm. Interference effects from the steel reinforcement grid is avoided by proper placement of the probe on the reinforced concrete surfaces. For measurements in soil, a separate set of four probes is used.

The result is that the electrical resistivity of any environment like concrete and soil can be quickly measured at any time without disturbing the system.

Four probe resistivity meter (FPR meter) is an instrument used to measure the electrical resistivity of the concrete in the RCC structures. In this instrument, three push button switche S_1, S_2 and S_3 are provided for operation A 3 1/2 digit liquid crystal disply has been provided for easy readout in the ambient light conditions and it consumes very less power. A triming potentiometer is provided at the bottom of the unit for calibration purpose. This instrument is a portable and battery operated one.

According to the present invention, there is provided a direct reading four probe resistivity meter for measurment of electrical resistivity of any environment such as soil and concrete ~~and the like~~ which comprises four probes arranged side by side, each probe being spring mounted on a frame, the terminals of the outer probes being connected to a constant current source, a square wave generator being connected to the constant current source, the inner probes being conneted to a commutator for converting the potential drop between the inner probes into resistivity, the

outputs of the commutator being connected to a display, digital unit, the entire assembly being housed in a cabinet, the cabinet being provided with switches for testing, calibrating and measurement.

According to another feature of the invention the digital unit is a LCD panel meter.

The invention is further illustrated with reference to the drawings accompanying the provisional specification.

The instrument according to this invention consists of a built in spring loaded four probe unit and electronic circuits for conversion of the current-voltage data in terms of resistance and scaling of the data to display the resistivity in digital panel meter. The schematic block diagram of the meter is shown in figure 1. of the drawings accompanying the provisional specificaition. Block (1) is the square wave generator for supply of (A.C.) current and Block (2) is the constant current source which impresses a constant (AC) current through the two outer probes C_1 and C_2 as shown in block (3). The purpose of the square wave generator is to avoid polarisation effects in the measurements. The potential drop between the two inner probes P_1 and P_2 of block (3) is fed to a commutator shown in block (4). The commutator converts the potential drop generated in the inner probes into signal, which is proportional to the resistivity of the environment to be measured. The resistivity is displayed in the digital display unit shown in block (5).

The construction details of the spring loaded built-in probe is shown in fig. 2.

The four probe unit is mounted in a PVC frame (6). Each of the four copper probes C_1, P_1, P_2, C_2 with pointed ends is threaded to a PVC tube connector (7) which is held in aluminium tube (8) and a spring (10) is provided between the aluminium head and PVC tube connector. The pointed end of the copper probe is wrapped with sponge (11) saturated with water for making effective contact with the concrete surface (12). The display unit (13) in which the electronic circuits are housed is mounted at the top of PVC frame (6). The push button switches (14) for operating the instrument are mounted at the top of the display unit (13). The resistivity is displayed in the digital panel meter (5) as shown in figure 3 of the drawings accompanying the specification. Fig. 3 is the plan view of Fig. 2.

For the operation of device, the following steps are taken:

i) Press the power ON switch and S_3

ii) Note the reading in the LCD display. The reading should be 16 or 159, depending upon the position of the switch S_2

iii) If the reading is not 16 or 159, the trimming potentiometer which is provided at the bottom of the unit is adjusted to read 16 or 159 as the case may be

iv) Release the switch S_3

v) Moisten the sponge with water for better electrical contact with the surface

vi) Place the instrument with probe assembly over the concrete surace and press gently

vii) Note the reading the LCD display. The display indicates the value of the resistivity of the concrete directly

WE CLAIM

1. A direct reading four probe resistivity meter for measurement of electrical resistivity of any environment such as soil and concrete which comprises four probe arranged side by side each probe being spring mounted on a frame, the terminals of the outer probes being connected to a constant current source, a square wave generator being connected to the constant current source, the inner probes being connected to a commutator for converting the potential drop between the timer probes into resistivity, the outputs of the commutator being connected to a digital display unit, the entire assembly being housed in a cabinet, the cabinet being provided with switches for testing, calibrating and measurement.

2. A direct reading four probe resistivity meter as claimed in claim 1 wherein the digital unit is a LCD panel meter.

3. An improved direct reading four probe resistivity meter substantially as herein described with reference to the drawings accompanying the provisional specification.

Dated this 29th day of August 1985.

N. R. Subbaram

(N.R. SUBBARAM)
JOINT ADVISER (PATENTS)
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

COMPLETE SPECIFICATION

COUNCIL OF SCIENTIFIC &
INDUSTRIAL RESEARCH

Nº OF SHEETS: 2
SHEET Nº: 1

Pat. Appln. No. 257/DEL/85
163185

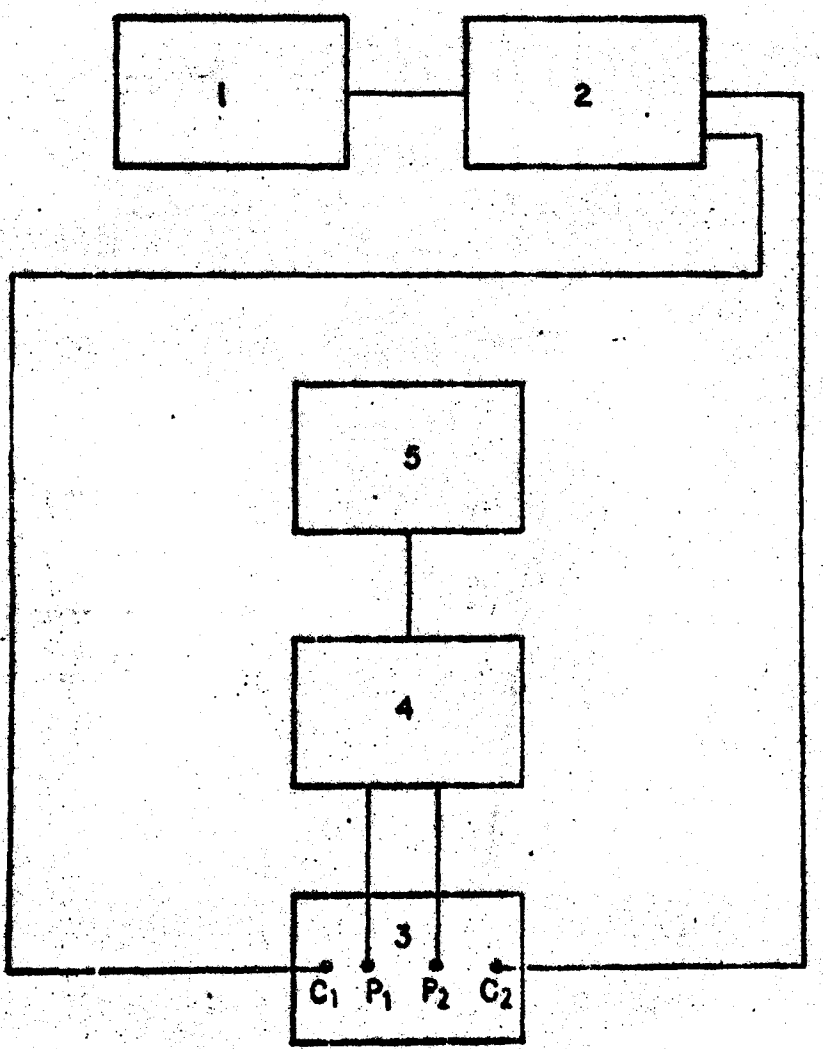

FIG. 1

N. R. Srinivasan

[illegible]AMAK,
PATENTS OFFICER,
C.S.I.R.

COMPLETE SPECIFICATION

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

Nº OF SHEETS: 2
SHEET Nº: 2

Pat. Appln. No. ~~28~~/~~160~~/85 163185

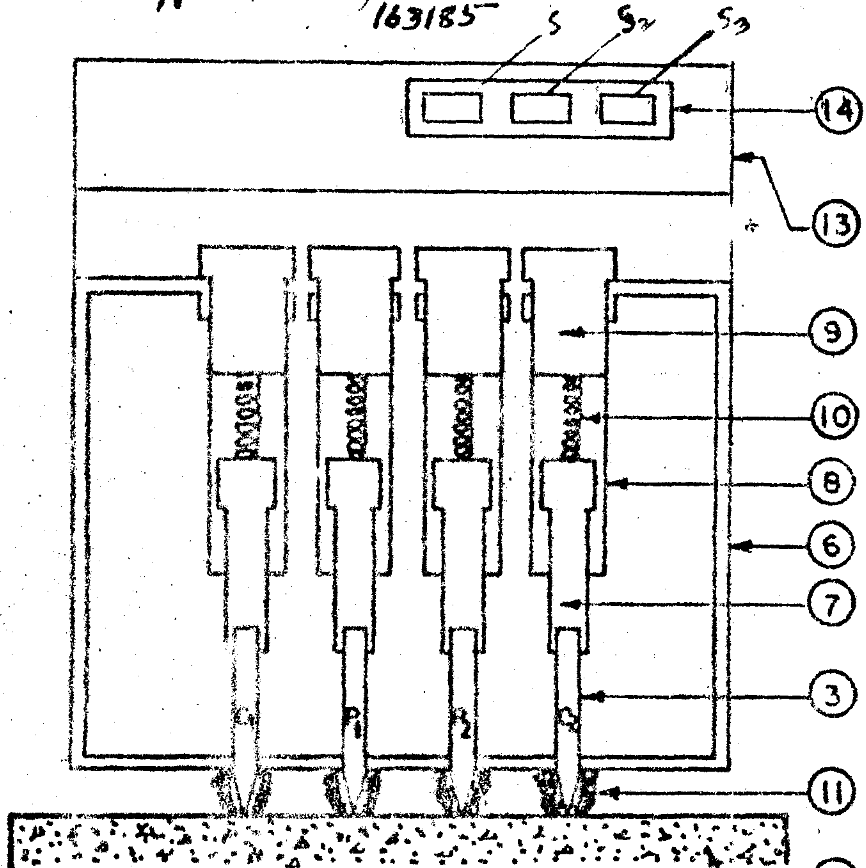

FIG. 2

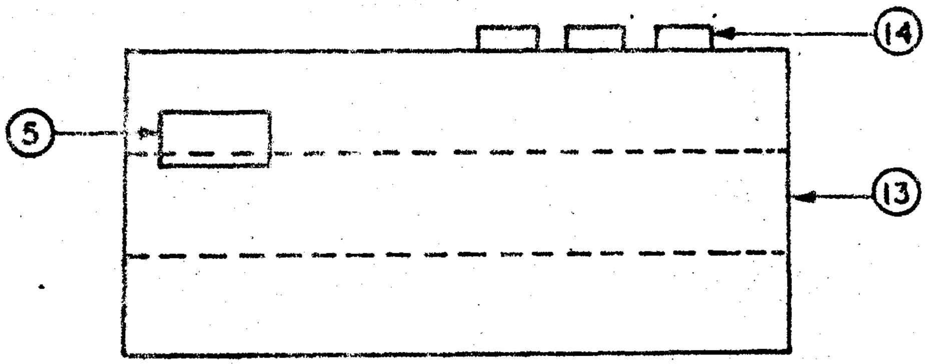

FIG. 3

N. R. S[illegible]

I.M.S. MAMAK.
PATENTS OFFICER,
C.S.I.R.