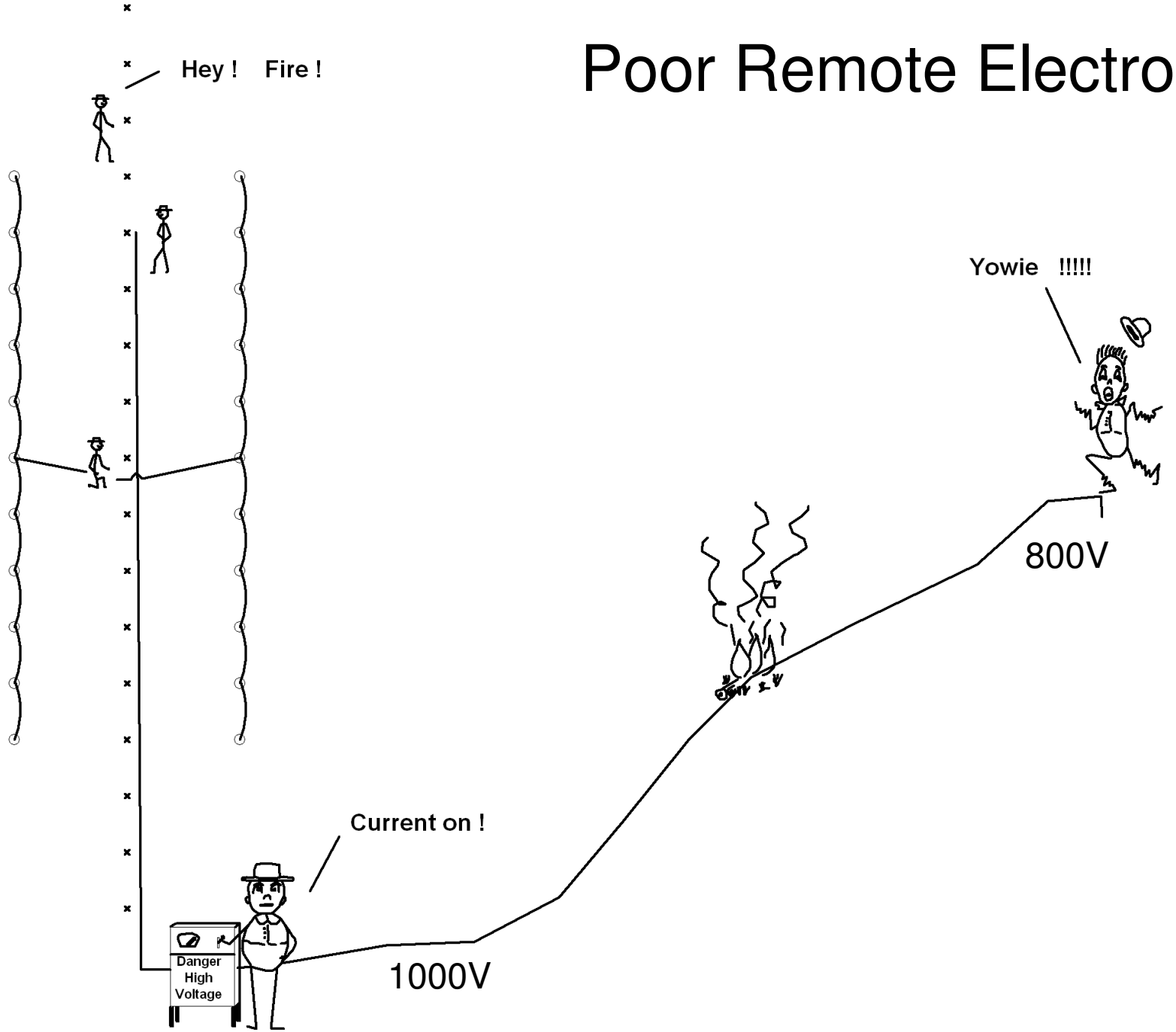
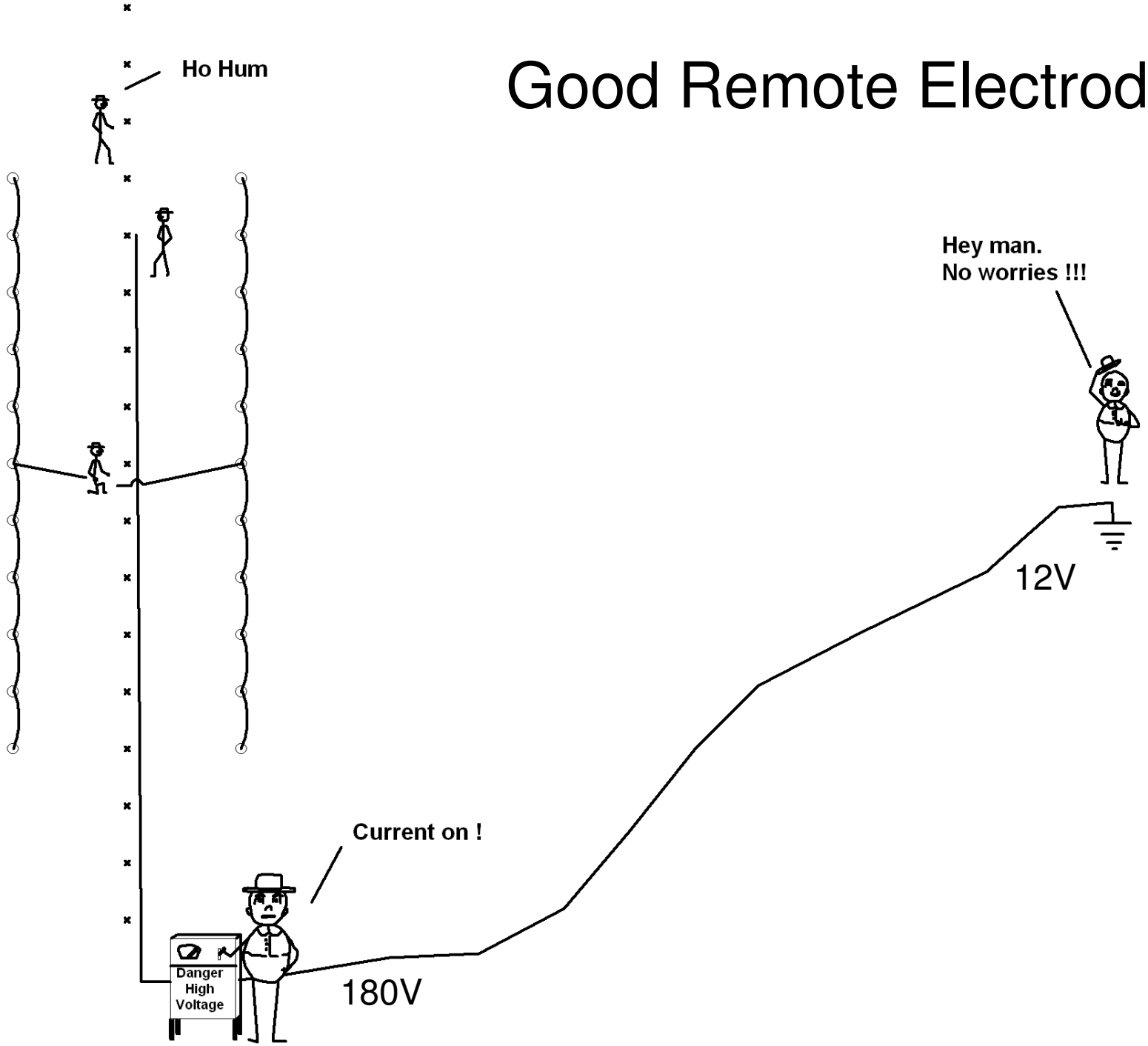
Electrical conduction in 3D
Common misunderstandings
Transmitter setup considerations

Steve Collins

Poor Remote Electrode



Good Remote Electrode



Good Electrode
or
Bad Electrode

Which do you prefer?
Why?

The answer is obvious – but....

How do you know how good an electrode is?

What can you do to improve it?

Make a bigger or deeper electrode?

“Is this deep enough yet?”

The problem is....

We are all brought up to think that electricity flows along wires in one dimension.

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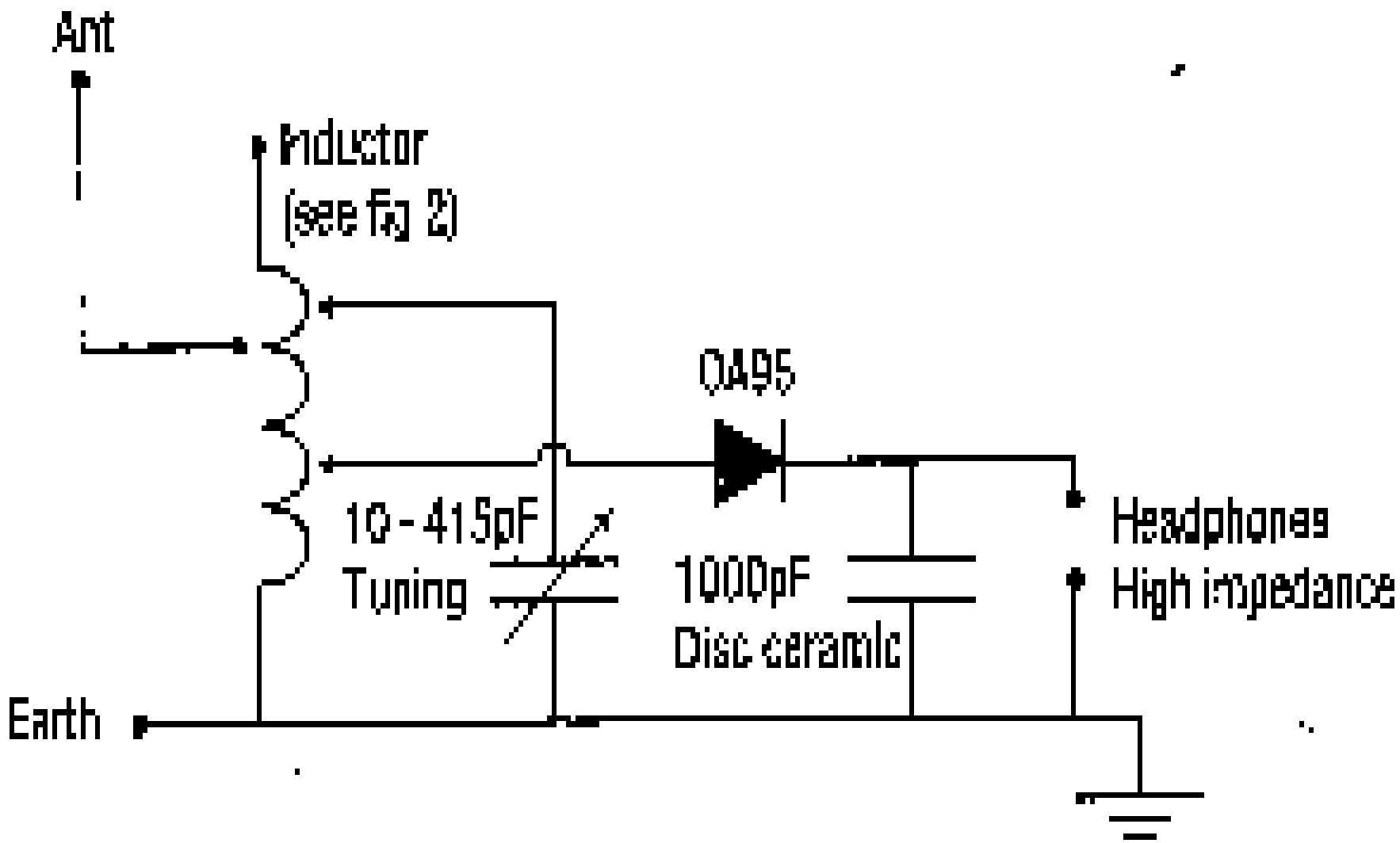
written by DICK SMITH

2nd PRINTING!


Ant
Inductor
(see fig 2)
OA95
10 - 415pF
Tuning
1000pF
Disc ceramic
Headphones
High impedance
Earth

But the real world is not like that

Consider the following electrodes.

Which is the better?

Significantly less than 300 ohms

VERSUS

The sign says 'High Voltage'.

But how dangerous is it to swim in this water?


DANGER
HIGH
VOLTAGE

How can we measure electrode resistance in real situations?

Very, very simply!

We need to measure the resistance between the electrode and infinity.

We know the current going in but what is the voltage between here and infinity?

In practical terms – How far is infinity?

If for simplicity, we assume the electrode is a hemisphere 2m across. The ratio of the potential as we move away from the electrode to the potential at the electrode is just the reciprocal of the distance.

In other words at 100m from the electrode you are 99% of the way to infinity (electrically that is!).

And for a smaller electrode you are further still.

An aside....
Other implications of this.

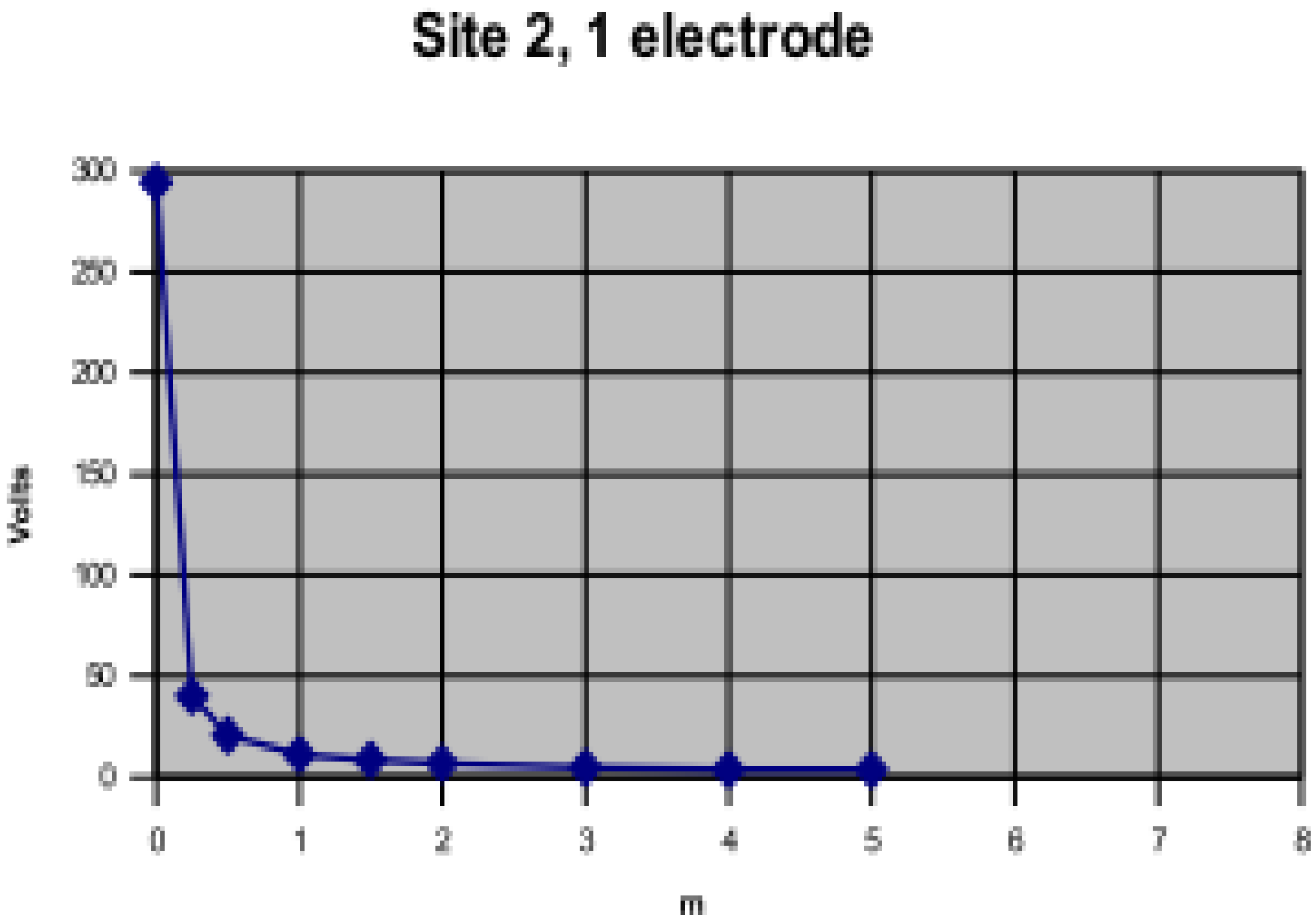
99% of the power of your transmitter is dissipated within 10 metres of the electrodes.

Putting a second electrode 10 metres away has the same effect as doubling your transmitter power.

So we set out to measure the resistance of real field electrodes

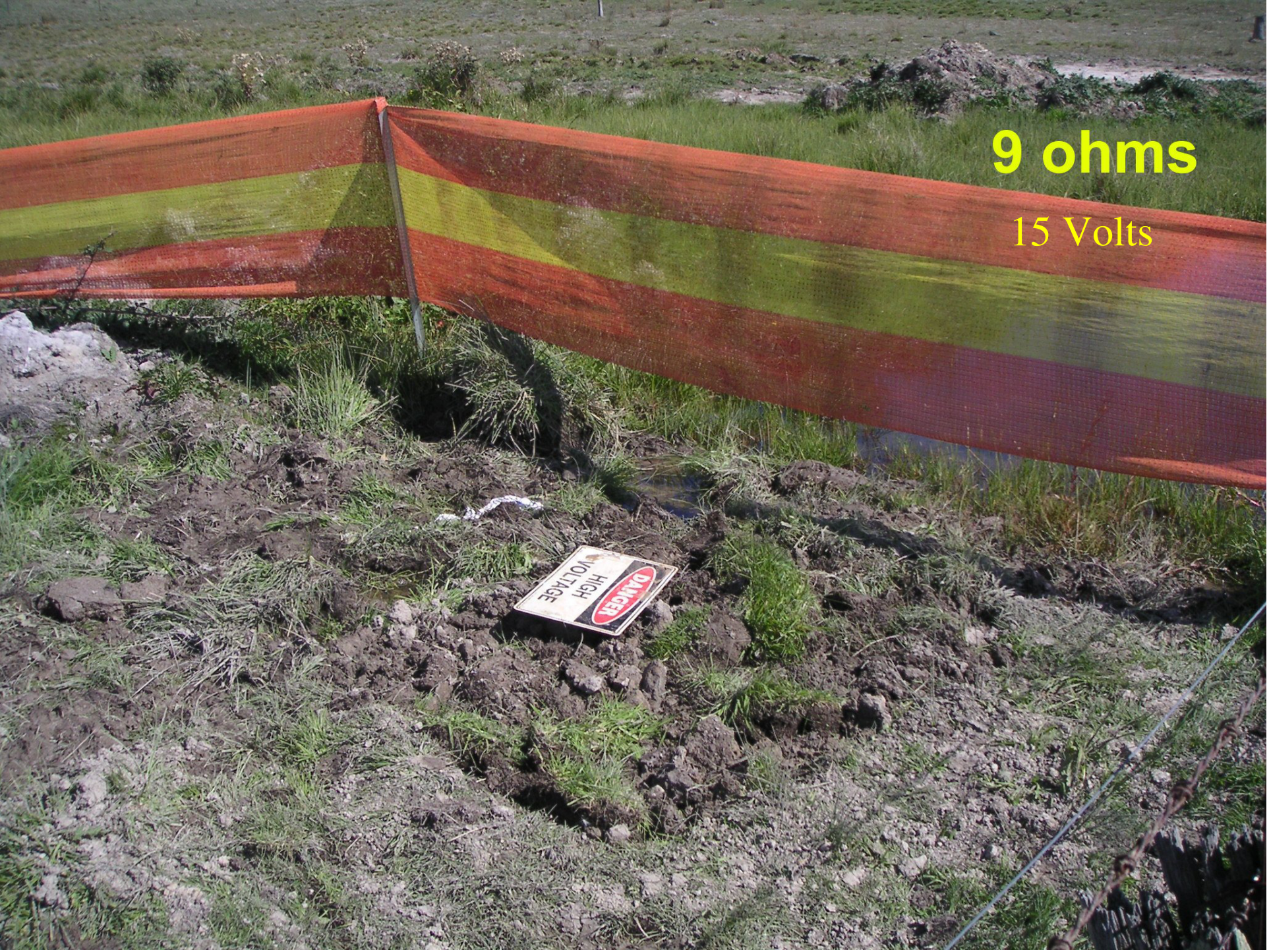
First we plotted how the potential falls off with distance
(relative to a point at least 100m away).


0.01
Auto
Display
Backlight


Site 2, 1 electrode
Volts
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
m

We measured the resistance of real electrodes in the field

Some were outstanding having very low (and safe) potentials.

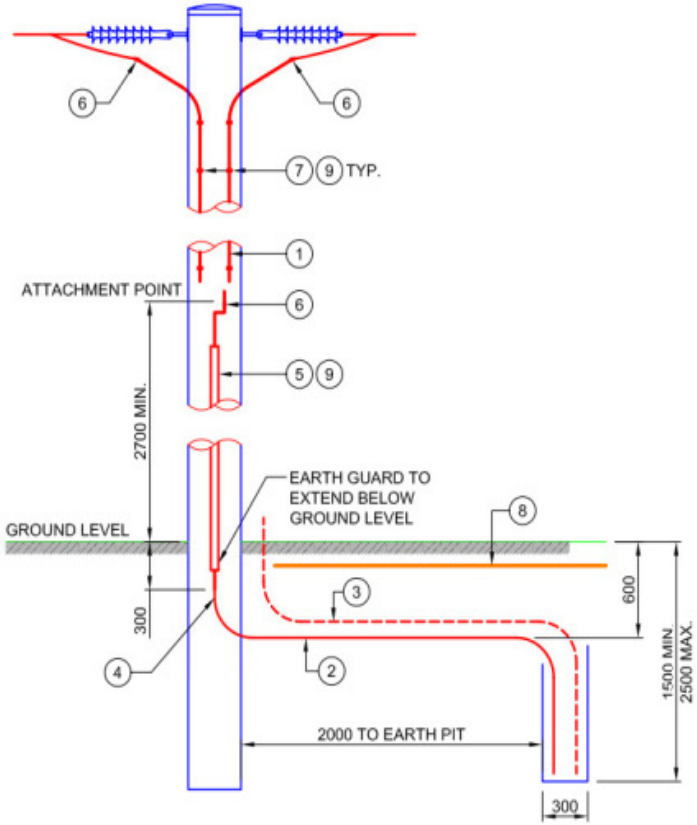

9 ohms
15 Volts
DANGER
HIGH
VOLTAGE


4 Plates in Dam Mud
Total 8 ohms

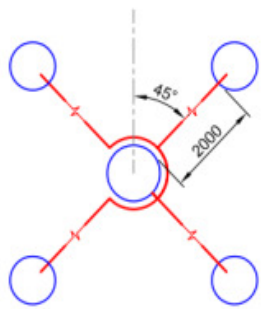
Including....

Possibly the world's first (and last?) engineer designed transmitter electrode


8-12 ohms



EARTH SYSTEM LAYOUT
ELEVATION



EARTH SYSTEM LAYOUT
PLAN

NOTES:

1. FOR DEEP DRILLED EARTHING USE BARE EARTHING CONDUCTOR IN HOLE INSTEAD OF EARTH STAKES WHERE POSSIBLE.
2. DISTANCE BETWEEN ELECTRODE SETS TO BE AT LEAST EQUAL TO (PREFERRABLY TWICE) TOTAL DEPTH OF ELECTRODES.
3. JOIN BARE TO INSULATED EARTHWIRES TOGETHER AS CLOSE AS POSSIBLE TO POLE.
4. JOIN EARTHWIRES TO EARTH ELECTRODES WITH 'C' CRIMP CLAMPS.
5. ALL EARTH CONDUCTORS ON POLE AND TO FIRST ELECTRODE ARE TO BE INSULATED TO MIN. 300mm COVER
6. INSTALL MARKER TAPE 150mm BELOW GROUND LEVEL FOR ENTIRE LENGTH OF INSTALLATION.
7. TOTAL RESISTANCE TO BE LESS THAN 5 OHMS. EXTEND EARTH GRID IF NECESSARY.
8. HOLES TO BE BACKFILLED WITH SALT AND EARTH.
9. GROUND TO BE SATURATED USING PERFORATED AG LINE PRIOR TO TESTING.

MATERIALS LIST

No.	DESCRIPTION	QUANTITY REQUIRED
1	INSULATED 50mm² Cu CONDUCTOR	14m
2	BARE 50mm² Cu CONDUCTOR	20m
3	50mm PERFORATED AG LINE	20m
4	CLAMP 'C' CRIMP	3
5	BATTEN 3m PVC EARTH COVER	1
6	CLAMP PG 7/1.75 - 7/4.50	3
7	SADDLE 16mm GALV	10
8	TAPE 500mm x 40mm SOFT ORANGE ELECTRICITY	8m
9	SCREW 12G x 40mm TEK GALV H/H	AS REQ'D

ACTIVE ENERGY

WORK AS EXECUTED

WORK COMPLETED _____
NAME (Block Letters)

SIGNED _____

DATE COMPLETED _____

Figure 1
Electrode Design Schematic

ACTIVE ENERGY

Power Line Design & Construction

Postal & Site Address: 8 Hawthorn Pl, ORANGE NSW 2800
Ph (02) 6362 8708 Fax (02) 6363 1663
Email: design@activenergy.com.au

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Designed	TGP
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Printed	07/10/10
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EARTHING SYSTEM - OPTION A
FOR C. KELLY

AE Project No:
10068 A4

SHEET 1 OF 2

AMENDMENTS

1. ORIGINAL ISSUE	07/10/10

Some surprises

A surface (alfoil) pit had a lower resistance than a nearby augured plate electrode of about the same area.


70 ohms


114 ohms

And...

A much lower resistance than a plate in an augured hole in more porous ground.


310 ohms

As expected

Using salty water makes a significant difference.


With salt
140 ohms


With salt
35 ohms

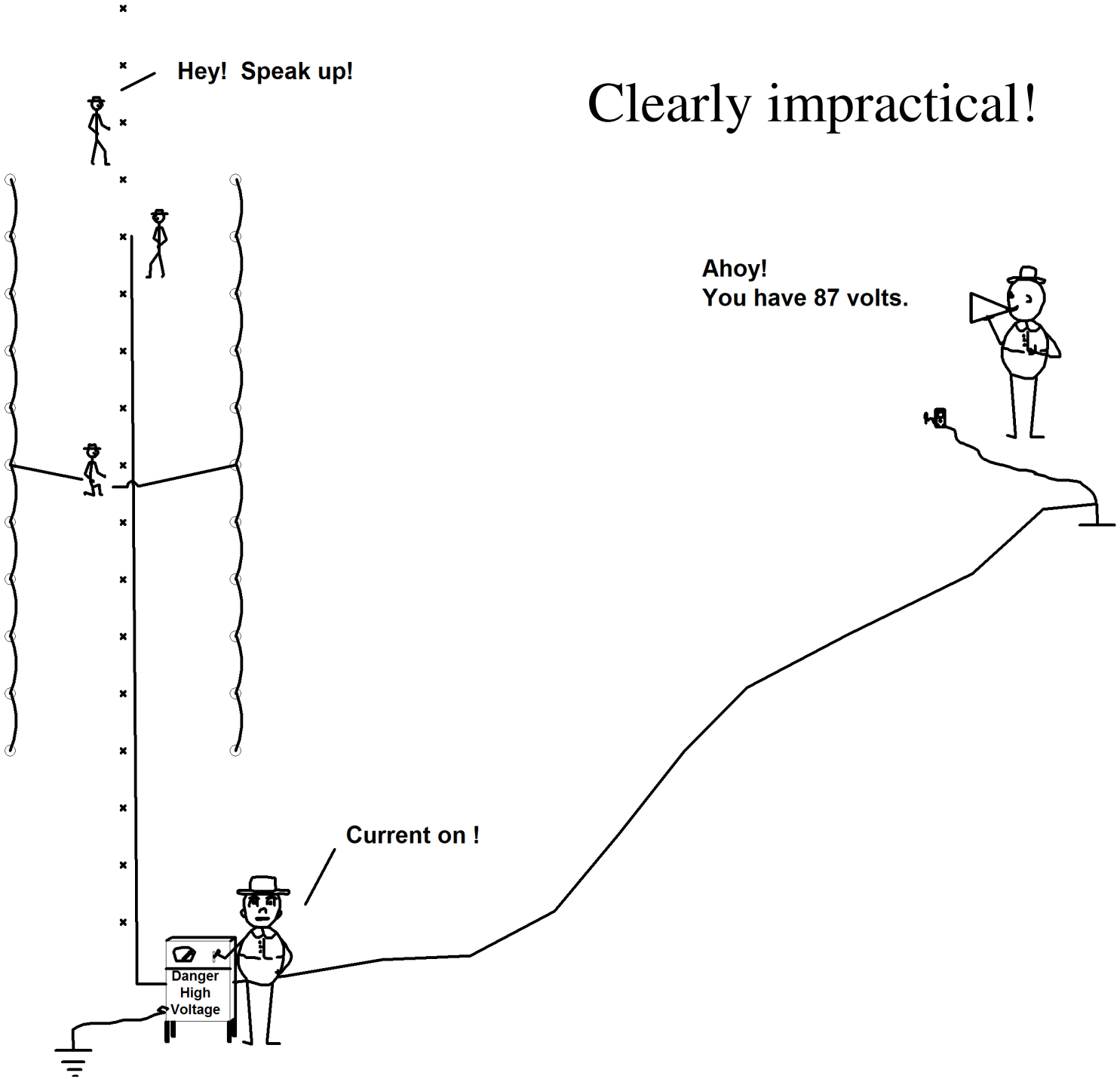

No salt
118 ohms
0.01
Auto
Display
Backlight

The wooden spoon goes to...

Single stakes – quick but deadly!


3000 ohms
Rewatered 1800

Clearly impractical!



It is impractical to measure the potential at each electrode.

But it is very easy to measure it at the transmitter and subtract off the wire resistance.

The transmitter already has a local earth that is more than 100m from the transmitter electrode

Measure the potential between the wire going to the electrode and the local earth. Divide by the current and subtract the wire resistance.

Hey presto – you have a quantitative measure of your electrodes' quality.

If you don't measure it

You don't know!

So you can't improve it.