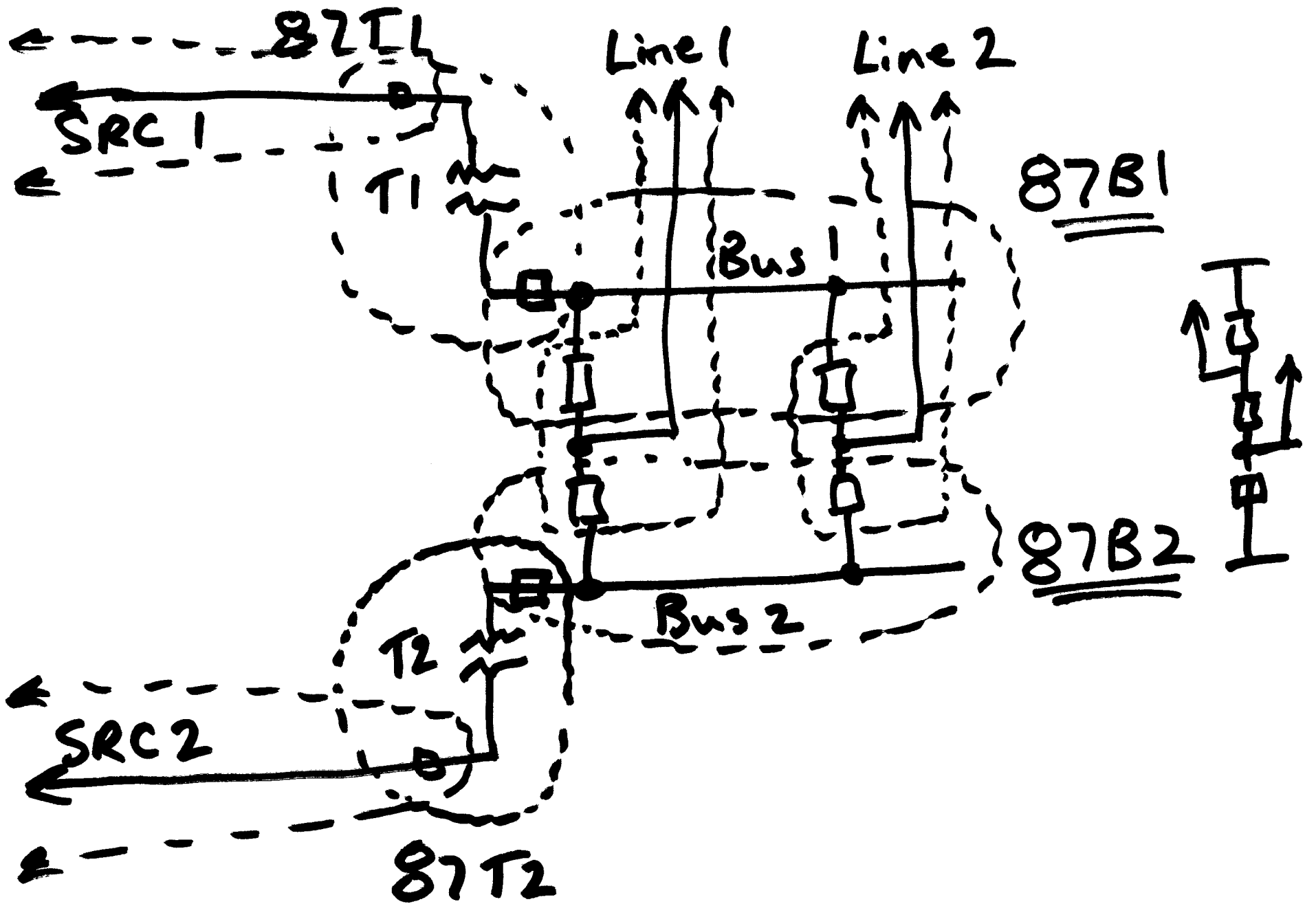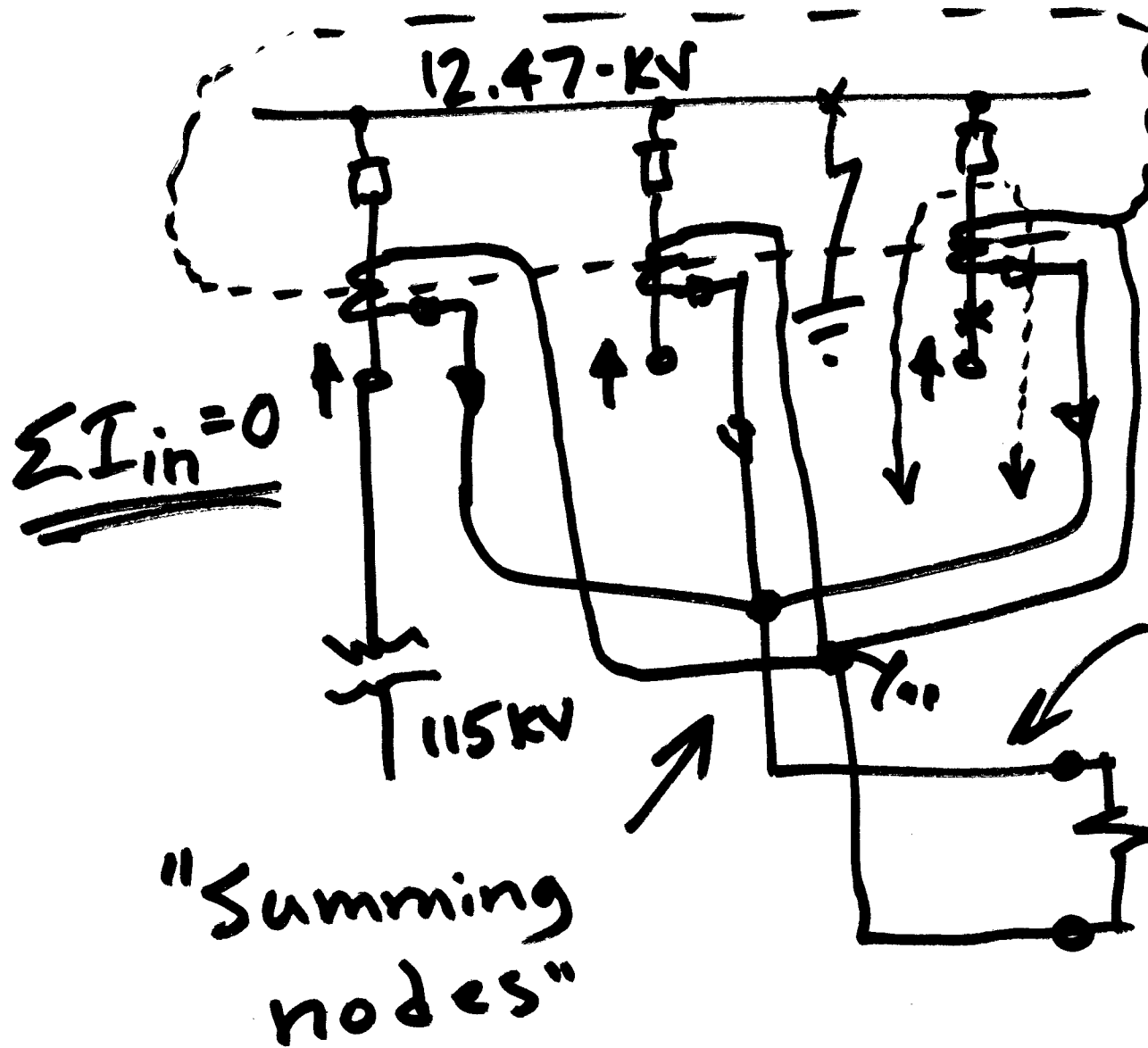**Ongoing List of Topics**:

- URL:  https://pages.mtu.edu/~bamork/EE5223/index.htm
- Term Project - all projects assumed firmed up and moving.
    - Follow timeline, see Term Project Guidelines posting on web page
    - Formal outline w/complete references complete, get/keep cranking...
- Transformer applications example - responsible but not collected (honor system)
- Homework set 11
    - Textbook problem 10.1 (very short)
- Midterm equiv Individual hmwks - posted soon
- Homework set 12 - "CAP" (not yet posted).
- Protection of Shunt Capacitor Banks (print out "Cap Bank Prot" at Week 12)
    - Basic application, reason for using shunt cap banks
    - Cap bank configurations - delta, wye, sectionalized (or "double") wye
    - Basic Methods of protection

82T1

SRC 1

T1

Line 1    Line 2

87B1

Bus 1

87B2

87T2

T2

SRC 2

Bus 2

# Single Bus, Single Breaker



12.47-KV

$\Sigma I_{in} = 0$

115KV

"Summing nodes"

$I \equiv 0$ normally.
$I >> 0$ for fault.

87B

Low Z ~ 0.1Ω
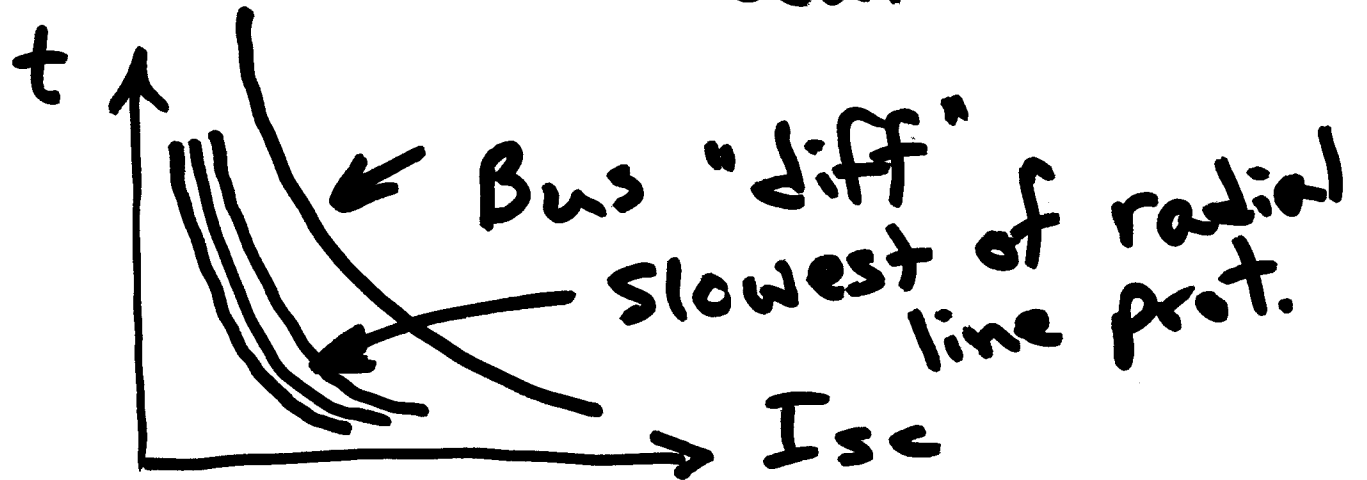Med Z ~ 5-15Ω
High Z ~ 2600Ω
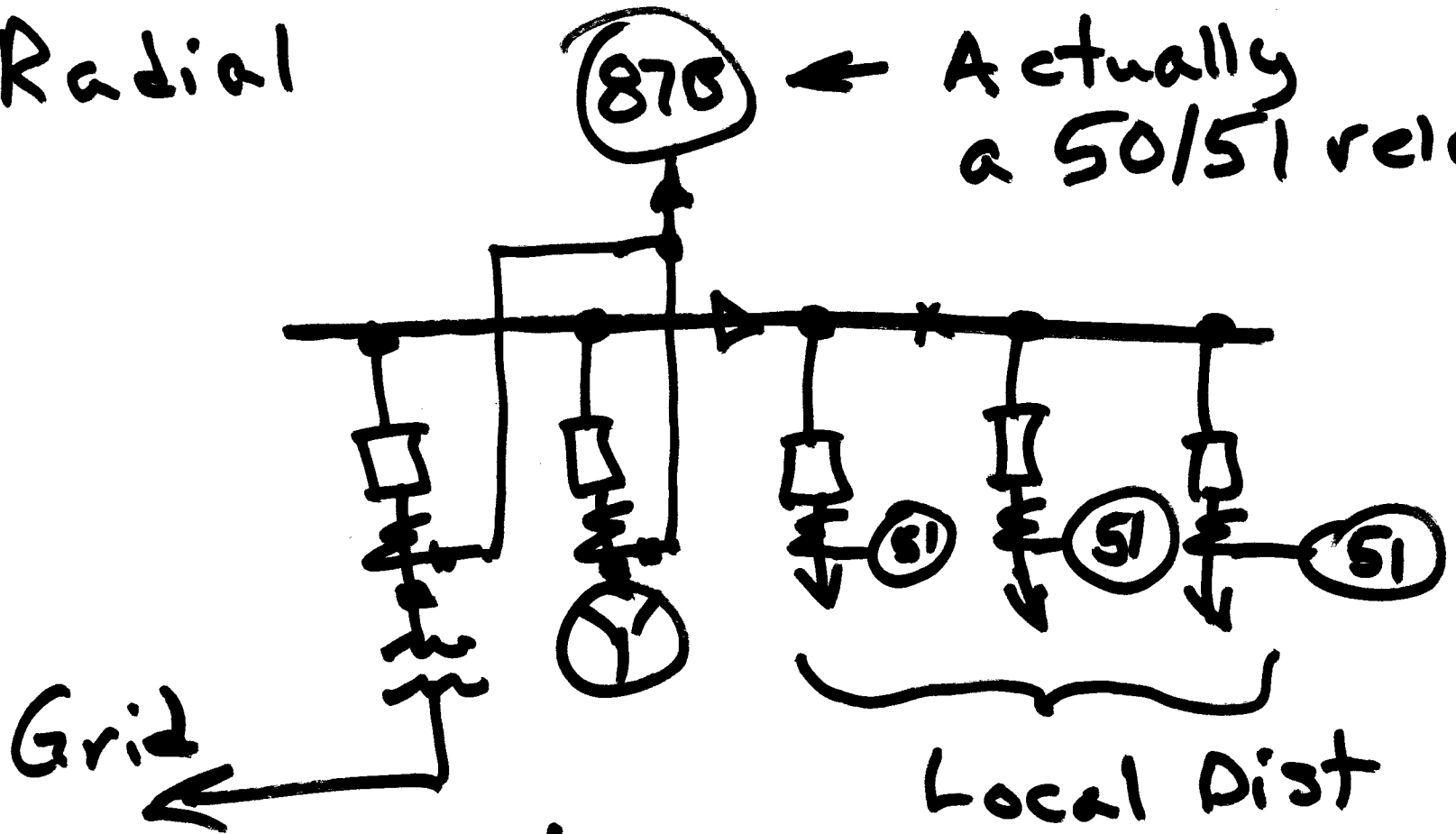
ABB/Ⓦ KAB

For MR CTs:
- All CTs at same ratio.
- use _Full_ (max) ratio for best results
- CTs should be 10Cxxx, i.e. uniformly distributed secondary windings.

# "Partial" Bus Protection (diff)
## – Radial



$(87B)$ ← Actually a 50/51 relay

Grid

Local Dist

Bus "diff" slowest of radial line prot.

$t$

$I_{sc}$

Generator Differential Mystery

Tom Ernst
2/9/2005

Dr Mork was discussing differential CT connections in today's lecture. Here is a little mystery for you to think about during Winter Carnival.

Last week I was at a local Municipal Utility starting-up a couple of 2 MW diesel generators. The first time they tried to carry load the differential relay tripped the unit. When I looked at the analog data from the generator relay (SEL-300G) I found something wrong with almost every CT connection.
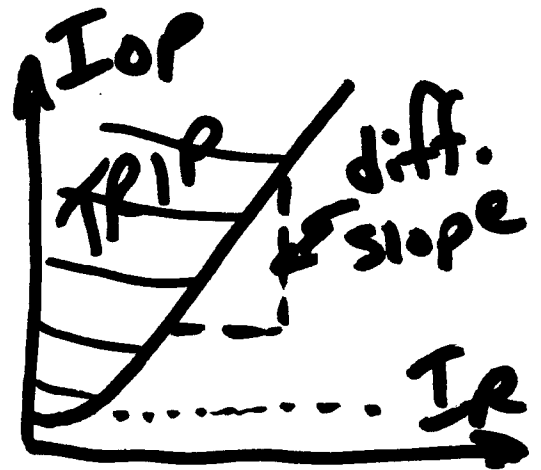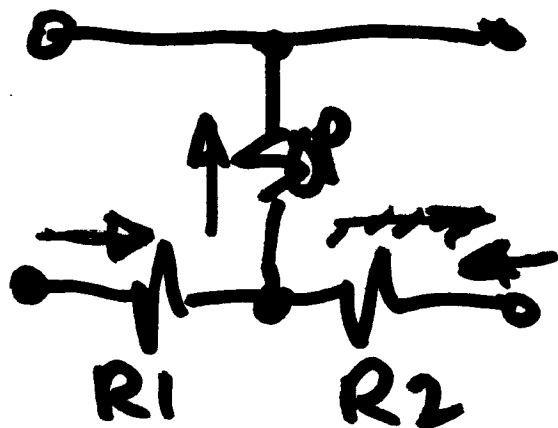
Here is a brief 1-line:
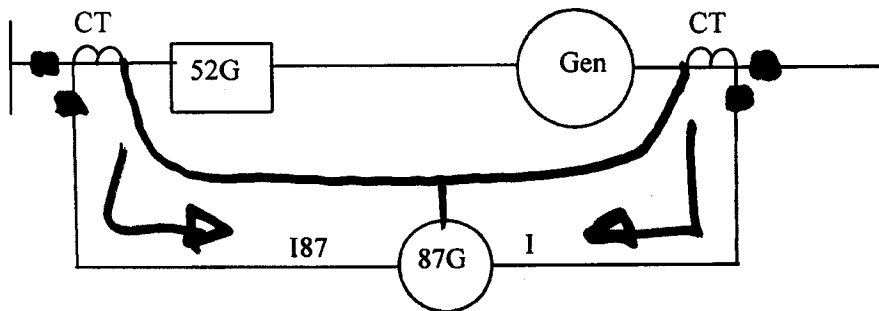


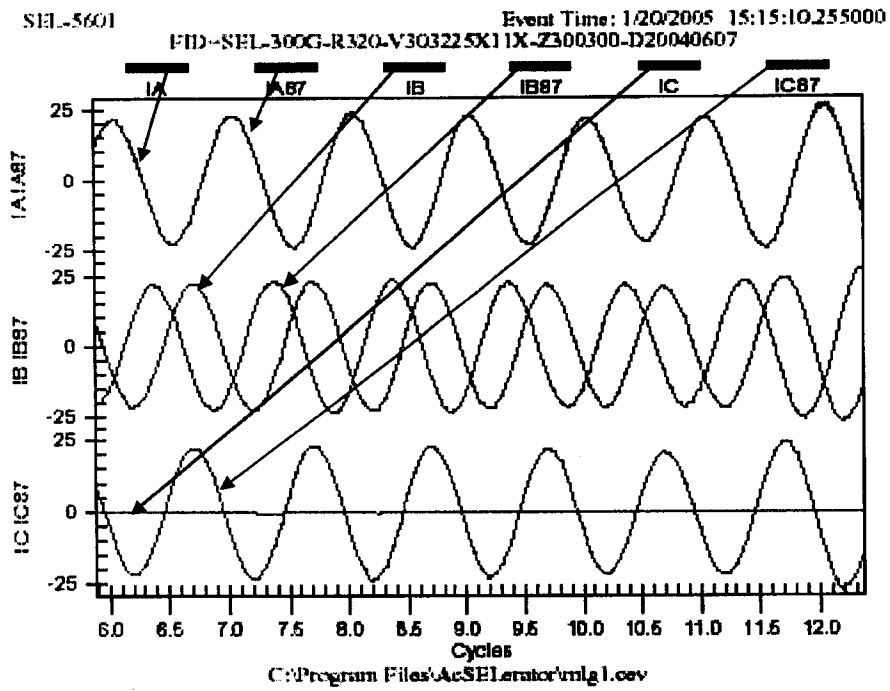Here is how the three currents should look when everything is OK:

A

B

C →

CB (52)
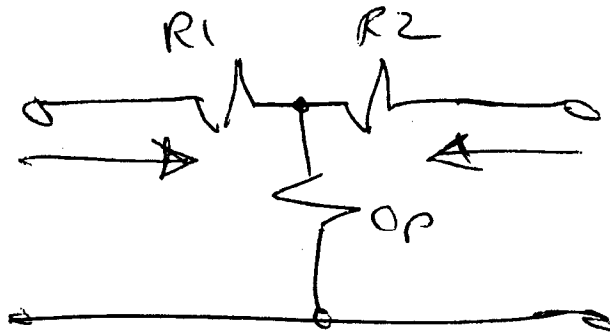
Neut.

876-C

R1    R2

$I_{OP}$

TRIP

diff. slope

$I_R$
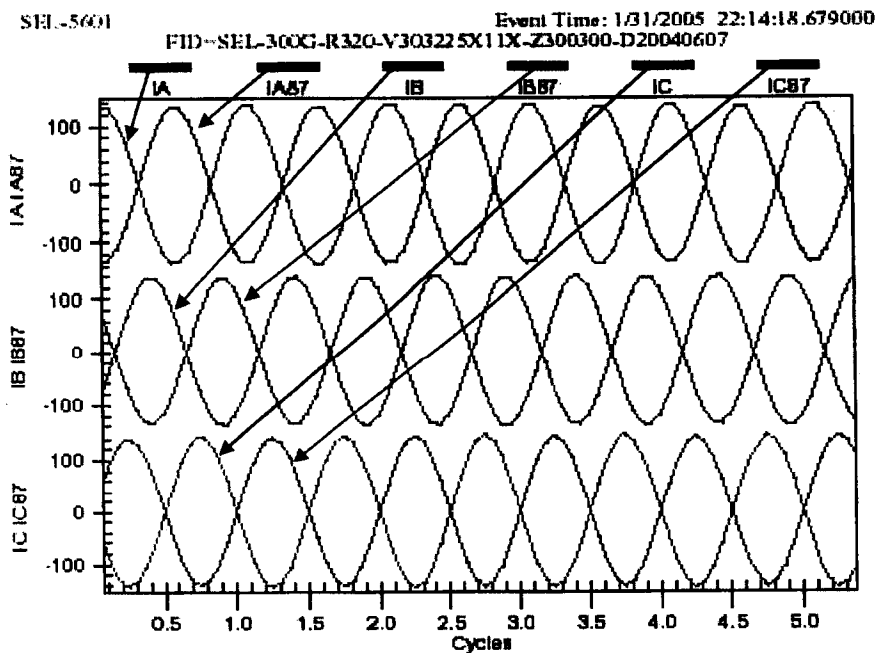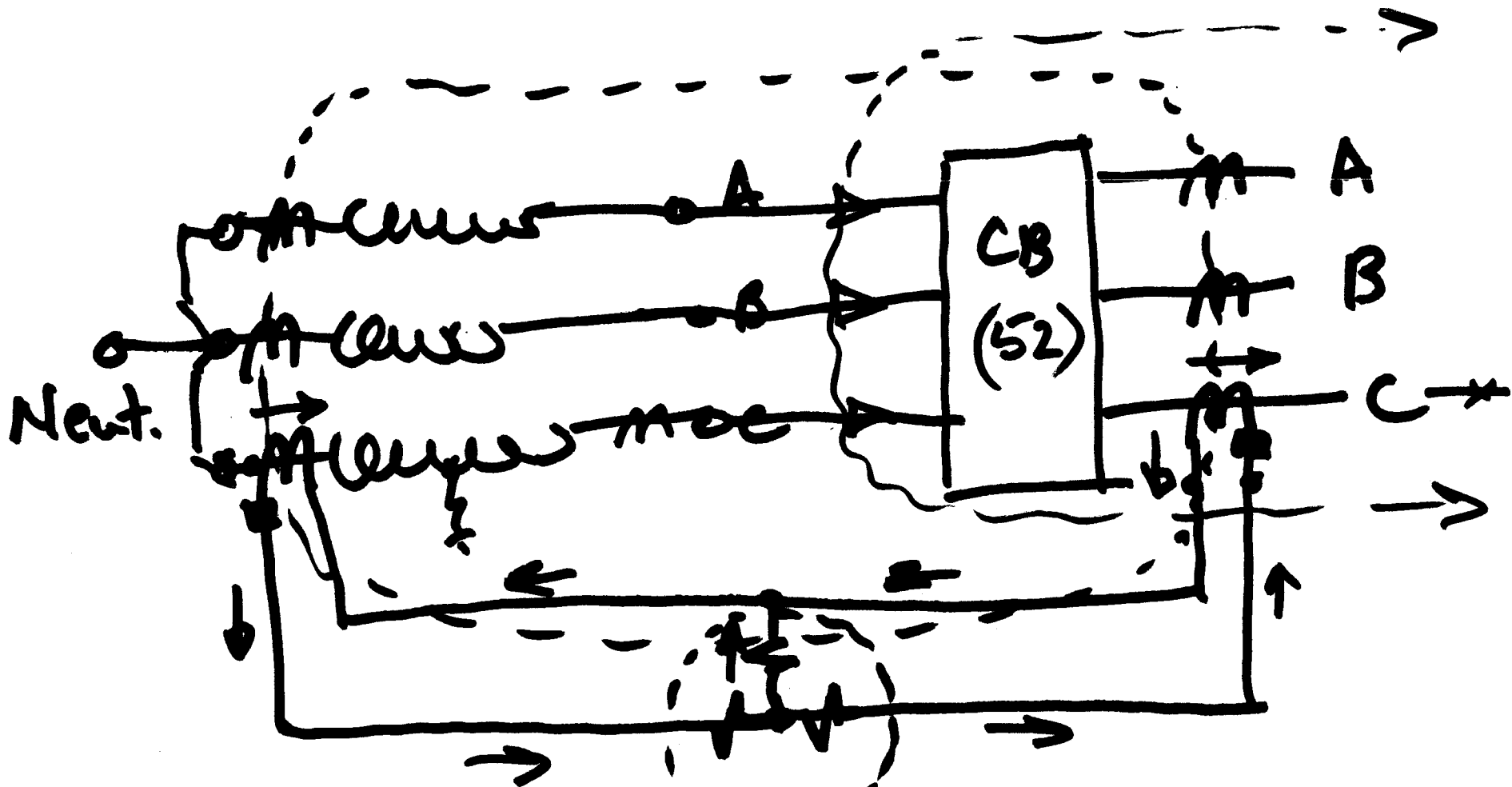
Here is what they looked like the first time they ran the unit:



Can you guess what is wrong with each CT?

The answers are on the next page:

Generator Differential Mystery                                    Tom Ernst
                                                                 2/9/2005

IA87 is wired reverse polarity (it should be 180 degrees out of phase with IA).
IB87 is really reverse polarity IC87 (it should be 180 degrees out of phase with IB and
120 degrees behind IA87).
IC is shorted out.
IC87 is really reverse polarity IB87 (It should be 120 degrees ahead of IA87).

This is easier to see if I swap IB87 and IC87 on the graphs:
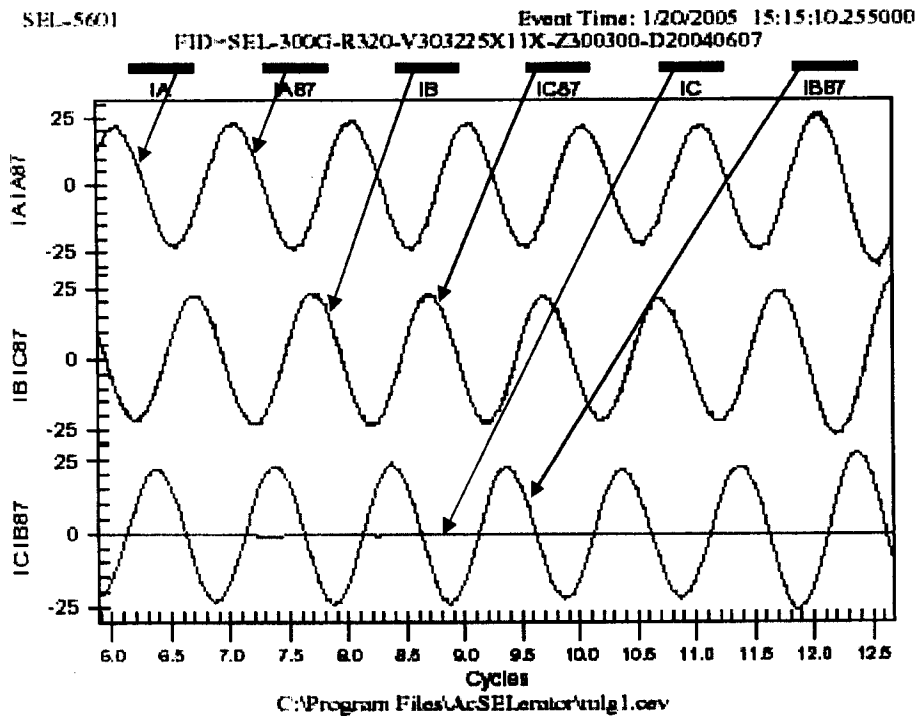


I think that I have never seen a differential connection with so many problems all at once!