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Methodical Phase Analysis

by

François (Frank) Gagnon

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April 2007 / Frank Gagnon

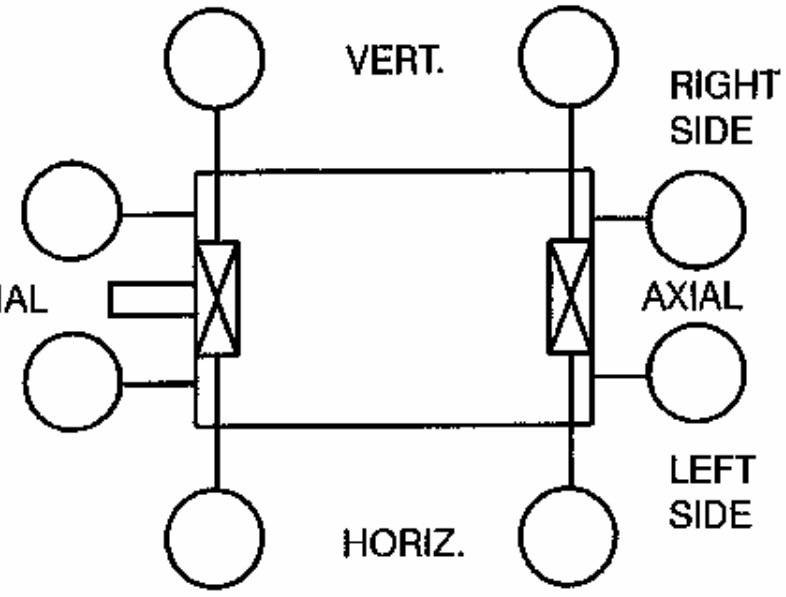
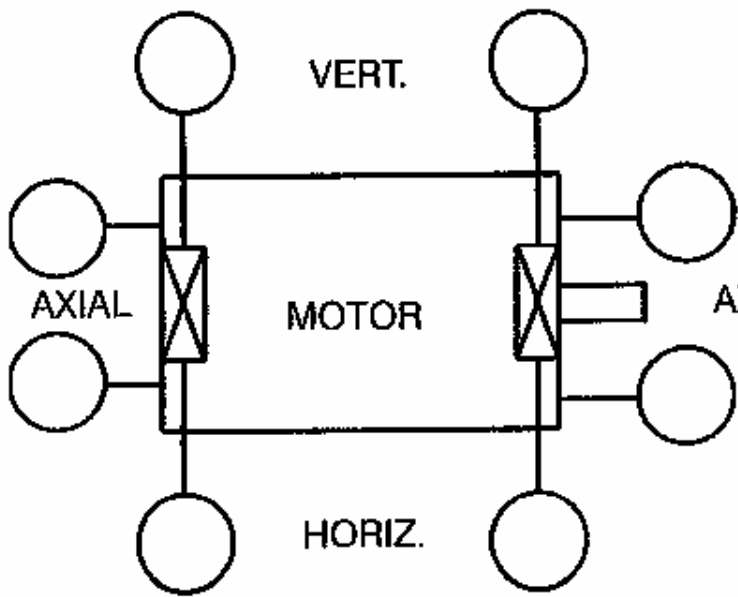
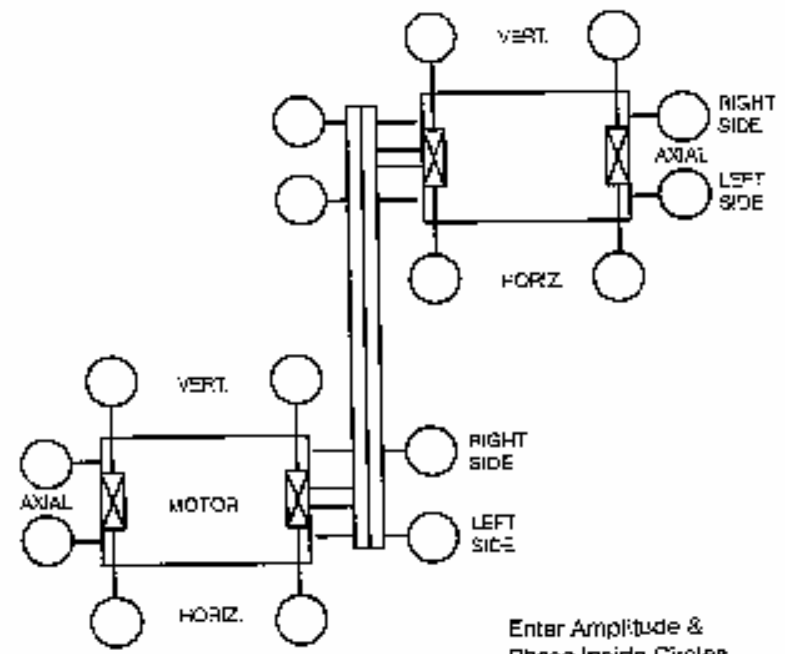
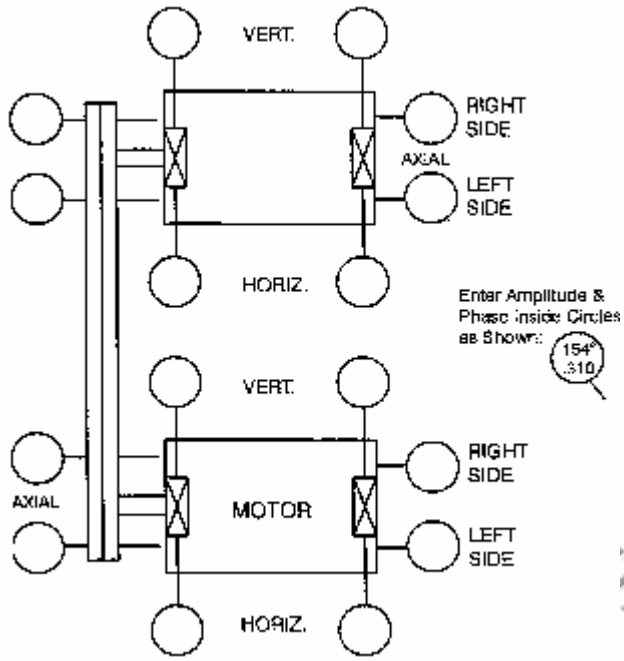
Breaking Down PHASE ANALYSIS into EASY STEPS

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Ultante

Phase & Unbalance

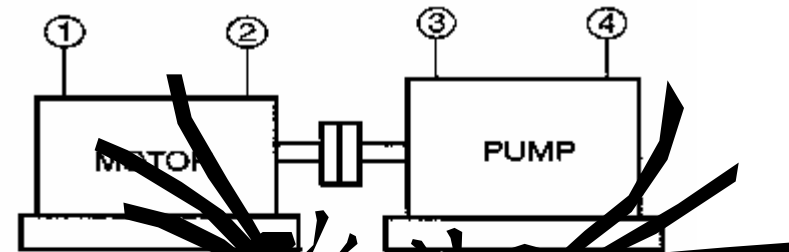


TABLE A.
PHASE AT 1X RPM FOR A MACHINE
WITH DOMINANT COUPLE UNBALANCE

DIR.	1	2	3	4
A	60°	120°	60°	*80°
H	90°	150°	30°	40°
V	120°	110°	120°	135°

* Corrected Phase Values Accounting For 180°
Orientation of Accelerometer.

TABLE B.
PHASE AT 1X RPM FOR A MACHINE
WITH DOMINANT COUPLE UNBALANCE

DIR.	2	3	4
A	*70°	60°	*80°
H	210°	200°	220°
V	120°	295°	280°

* Corrected Phase Values Accounting For 180°
Orientation of Accelerometer.

TABLE C.
PHASE AT 1X RPM FOR A MACHINE
WITH SIGNIFICANT DYNAMIC UNBALANCE

DIR.	1	2	3	4
A	90°	*70°	60°	*80°
H	30°	90°	80°	70°
V	120°	180°	170°	165°

* Corrected Phase Values Accounting For 180°
Orientation of Accelerometer.

Taking the pain
OUT of phase
analysis

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Phase implies a comparison

- Measured Phase in relation to...
- Rotor position (for balancing)
- Another point or location's measured phase
- What it was "before"

Phase Measurement

- Two-channel execution (comparative phase or complex spectra) offer the simplest approach
- No need for a visible reference off the rotor

Phase Analysis "Tolerance"

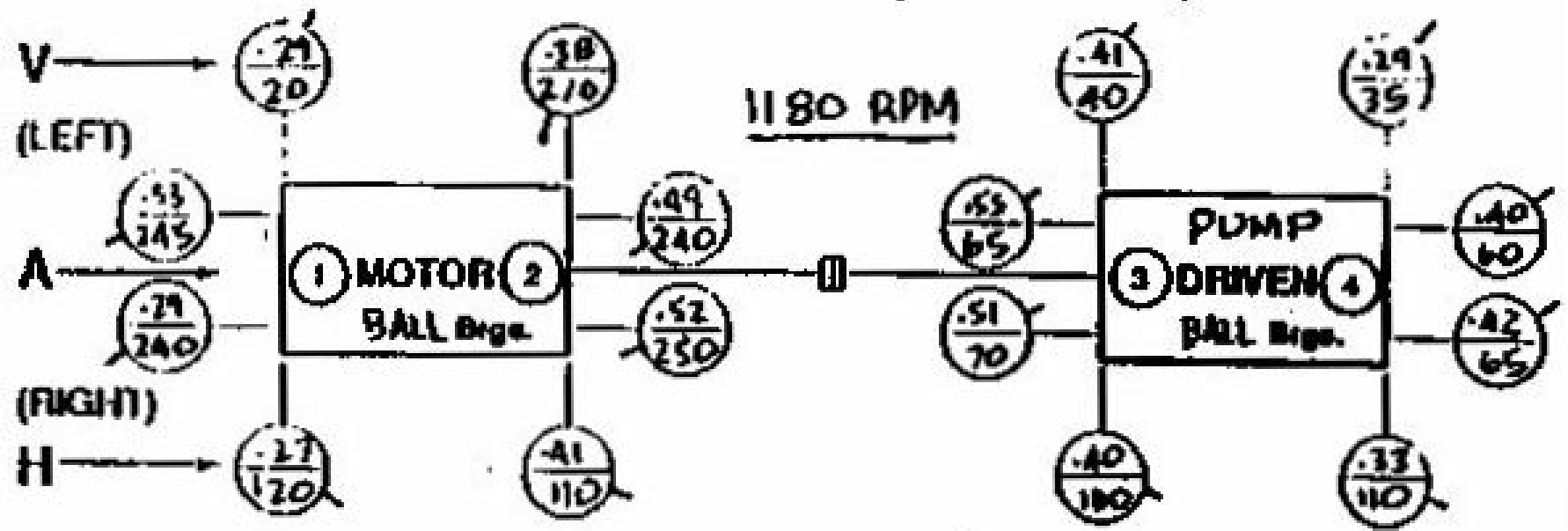
- The phase difference seen in the last two slides (tables) of this presentation allow for a "variation"
- Typically 30 degrees
- So 60° is equivalent to 90°

Phase Analysis "Tolerance"

- More than one phenomenon may be driving phase!
- Some authors suggest "up to 40° difference" as a tolerance: we find THIRTY is enough
- The caveat about two or more phenomena acting simultaneously does apply (such as, for example, unbalance AND misalignment)

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Complete Machine



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FIRST ROTOR / the motor

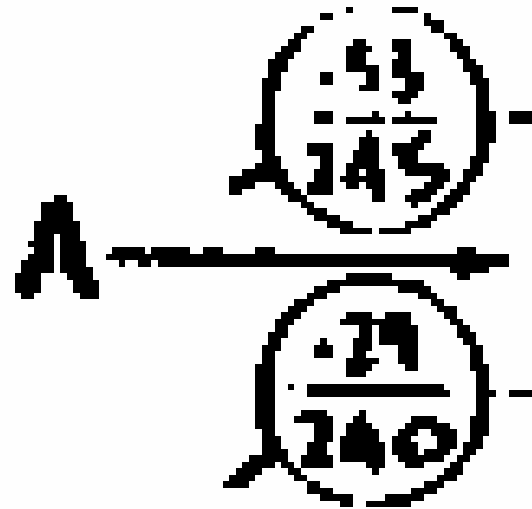
One rotor at a time in 6 easy steps

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First Step / OB Axial

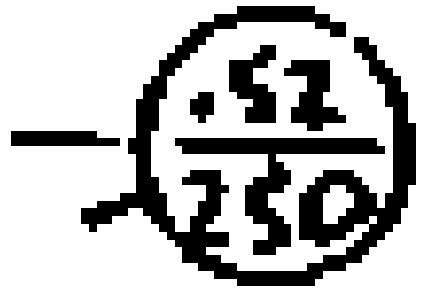
(LEFT)



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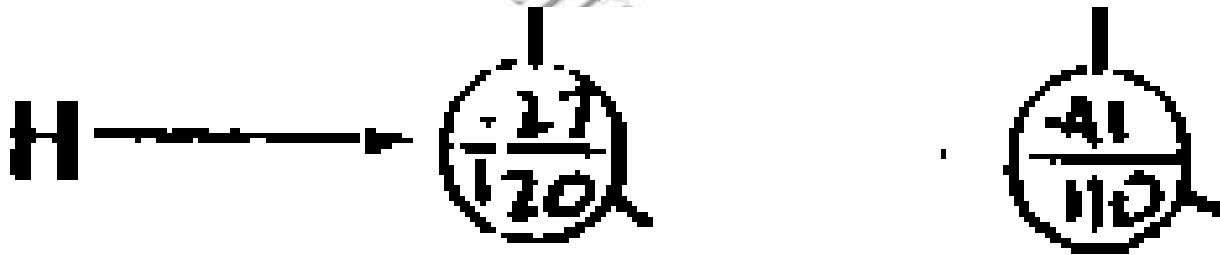
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2nd Step / IB Axial

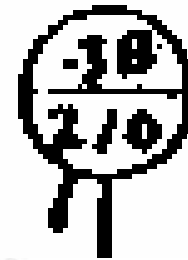
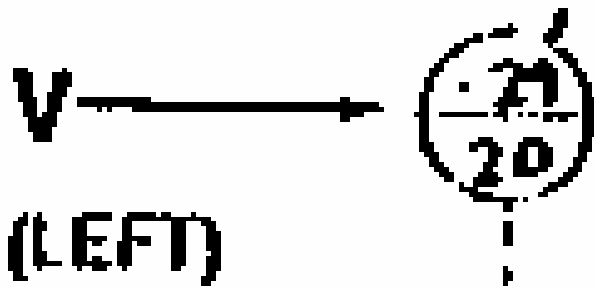


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3rd Step / H Phases together



4th Step / Vertical Phases



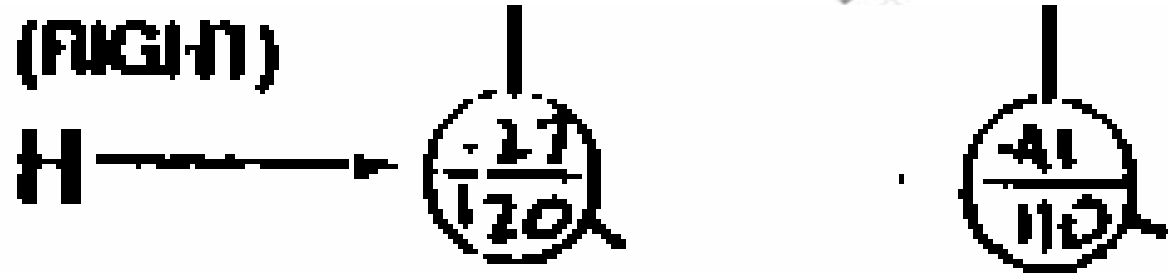
5th Step / Axial Phases Together

(LEFT)



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6th Step / H and V



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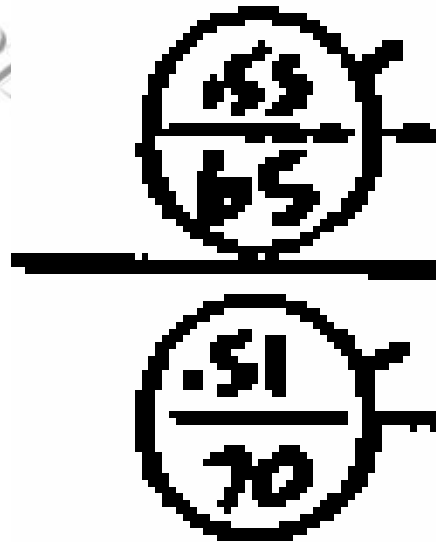
So far, what have we found ?



Second Rotor / the pump

Same six easy steps

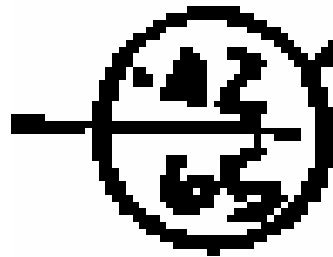
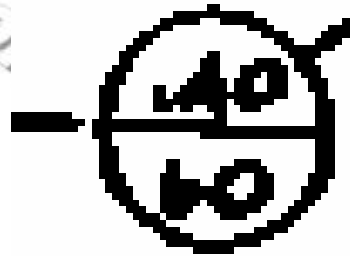
1- IB Axial



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2- OB axial

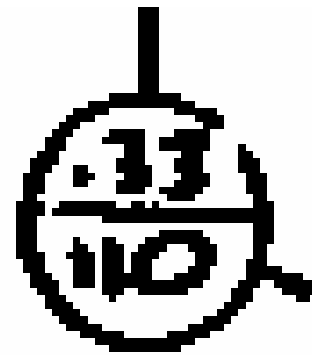
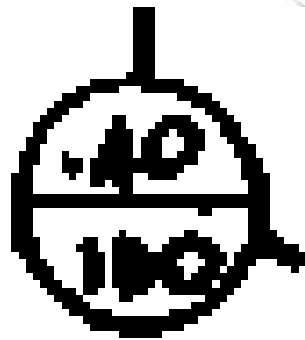


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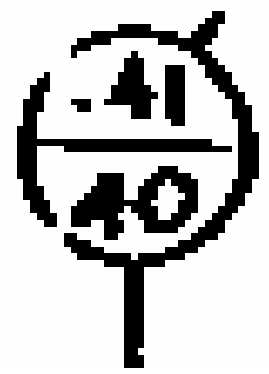
3- Horizontal Phases



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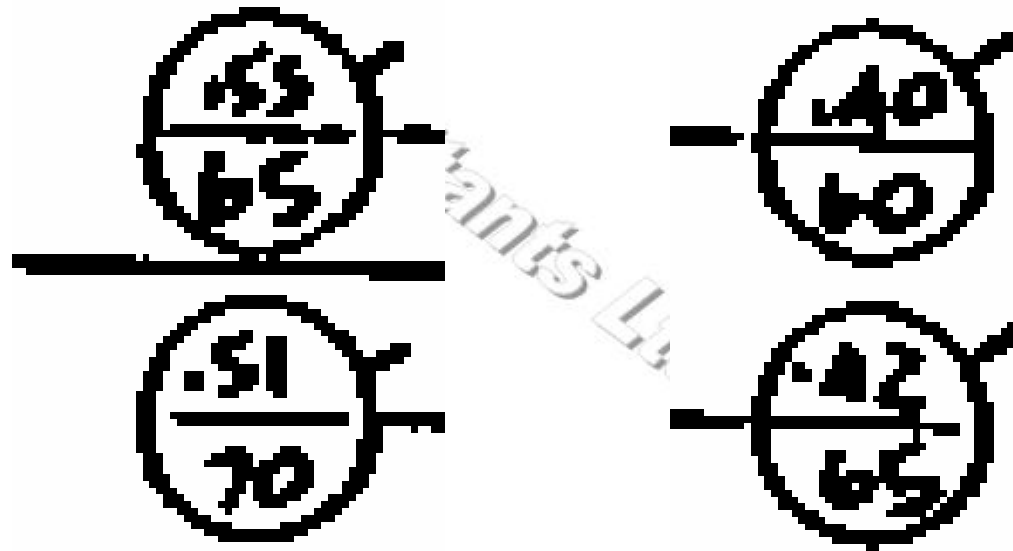
4- Vertical Phases



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5- Axials together

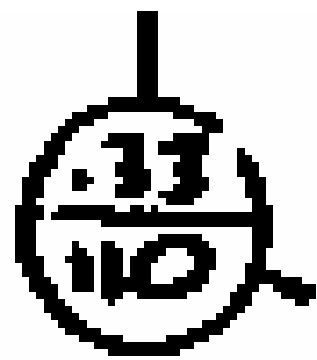
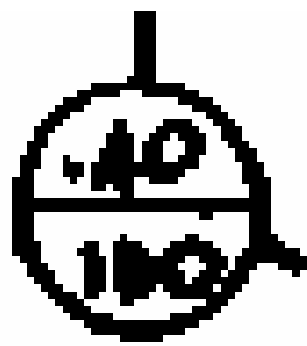
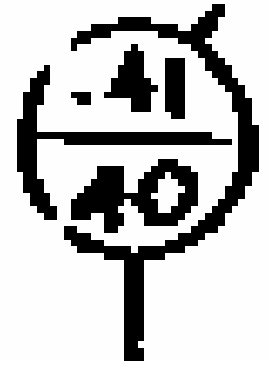


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6- H & V Together



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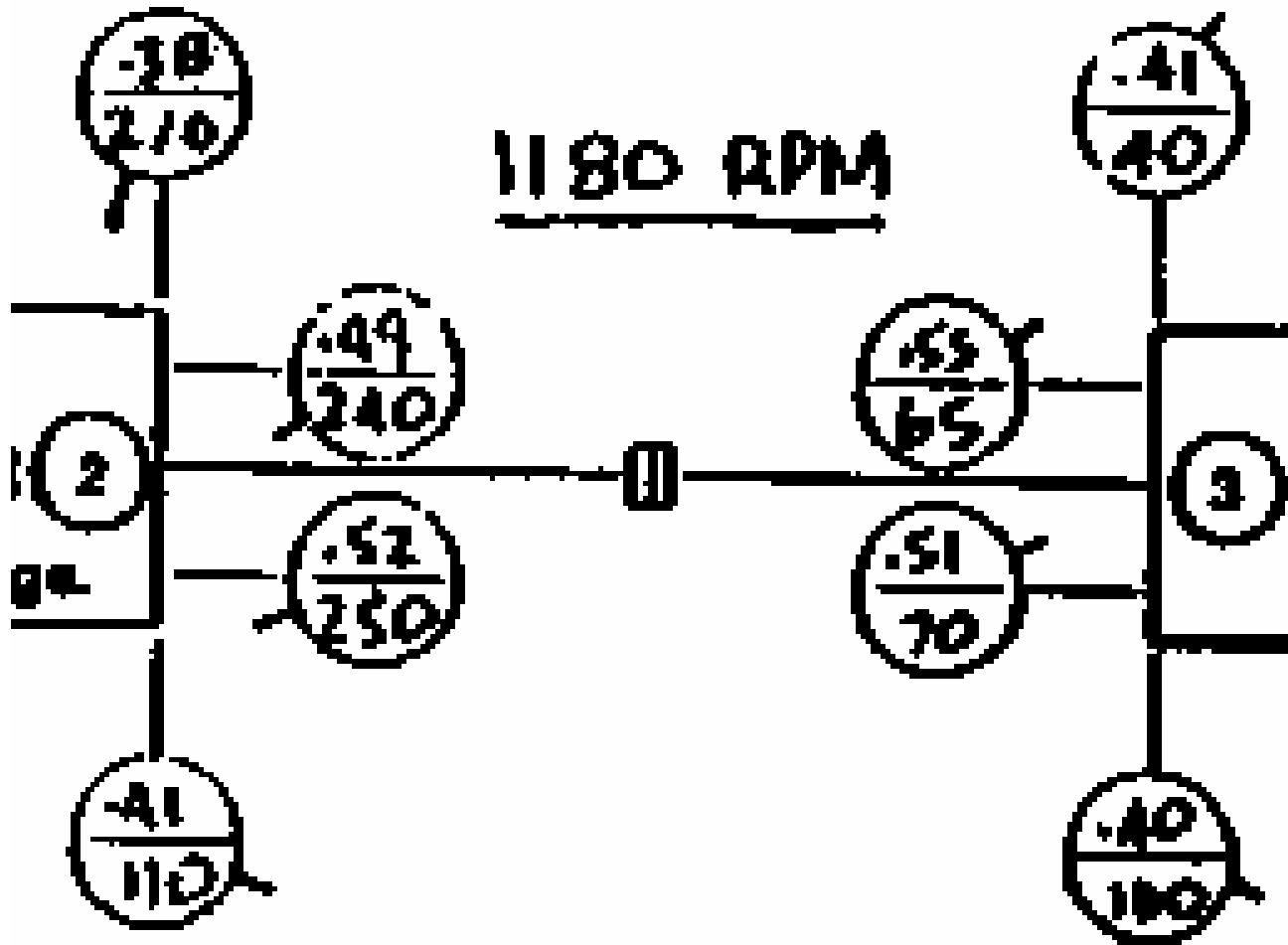
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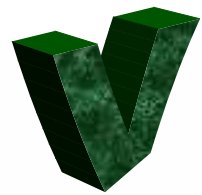
Both Rotors Together

ACROSS THE COUPLING in
two easy steps

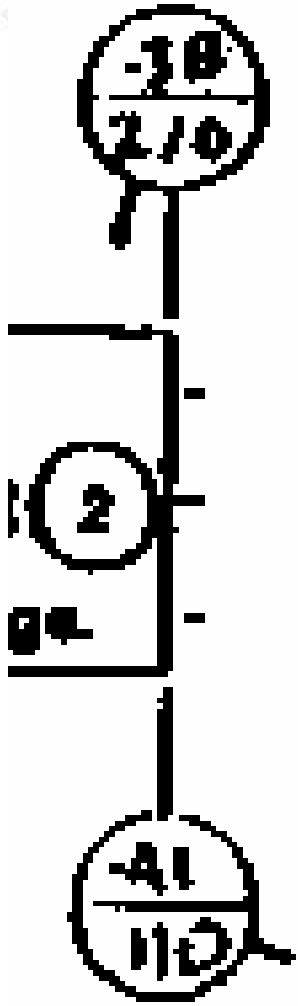
2) Radial Phases across the coupling



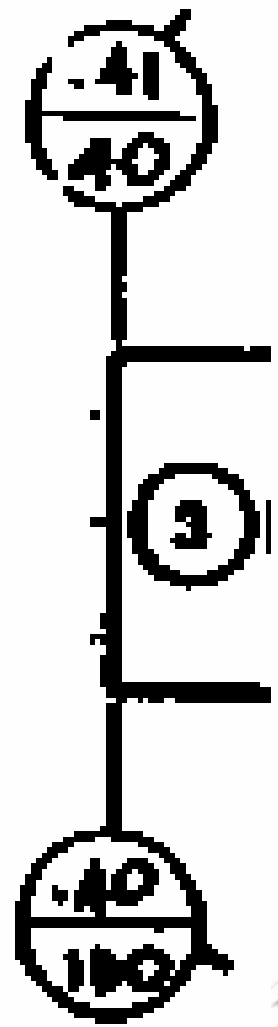
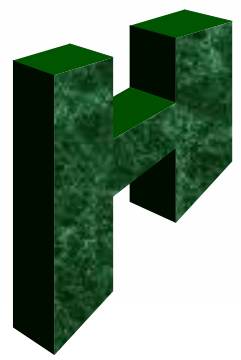
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1180 RPM



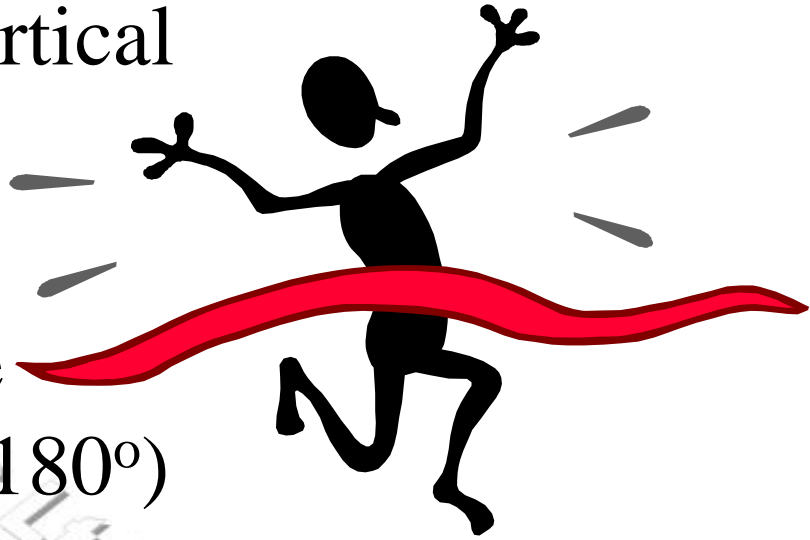
The intervening axial phases have been removed to avoid confusion...



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Conclusion ???

- Motor has abnormal vertical phase behavior (180°)
- Axial phases across the coupling are opposed (180°)
- Vertical phase across the coupling are opposed (180°)



Recap

- Complete phase analysis by seeking abnormalities...
- Review each rotor **ALONE**
 - Single bearing
 - Bearings compared
- Review rotor interface data



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Radial Phase Analysis

Phase Difference	0°	30 to 60°	90°	120 to 150°	180°
Unbalance (general)			H & V		
Static (force)	H & H V & V		H & V		
Couple			H & V		H & H V & V
Dynamic		H & H V & V	H & V	H & H V & V	
Eccentric	H & V				H & V
Resonance	H & V				H & V
Across coupling	Normal				Misalignment (parallel)

Axial Phase Analysis

Axial Phase	0°	30 to 60°	90°	120-150°	180°
Bearing Face	Normal All points		Abnormal (4 point system)		Abnormal (2 point system)
Across Rotor	Normal				Bent Shaft
Across Coupling	Normal				Angular Misalignment