POWER-TUNE
THE PHYSICS OF ITS WORKING PRINCIPLE EXPLAINED

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A. Introduction

a. The power-tune is essentially power factor capacitive element equipment for improving the load power factor of a normally inductive load.

b. It essentially provides a leading current injection phasor into the normally lagging inductive loads that are characteristic of electrical loads present in the household.

c. A household power point (13A) distribution circuit normally has three (3) 13A power-point socket outlets connected in parallel, as shown below.

d. The first power point in the distribution circuit would be the best point for connecting the power-tune, as shown below in Figure 1.

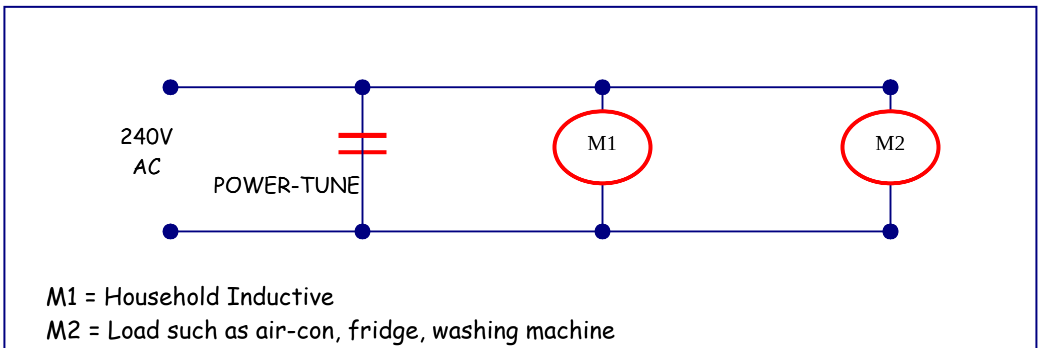

Figure 1: Illustrating the Concept

B. Example of Calculation to Demonstrate the Physics of Working Principle

a. Two air-conditioning loads, M1 and M2 each rated at 1.5hp and 2.5hp are connected as shown above.

b. Say, the two air-cons have an efficiency of 84% (ŋ) and a power factor of 0.8 lagging. We lump the two air-con loads as an equivalent load of 4hp, called M.

c. First, we need to calculate the input volt amperes, as such:

$$\eta = \frac{\text{output power (Watts)}}{\text{input power (Watts)}} = \frac{4 \times 786}{IV \times pf}$$

$$IV = \frac{2984}{0.8 \times 0.84} = \frac{2984}{0.672}$$

$$= \mathbf{4440\ VA}$$

d. Next, we calculate the current taken by the motor of the lumped air-con load (M) of 4hp, i.e.

Current taken by M;

$$\mathbf{Im} = \frac{\text{Input volt-ampere}}{\text{Voltage}} = \frac{4440}{240} = \mathbf{18.5\ Amps}$$

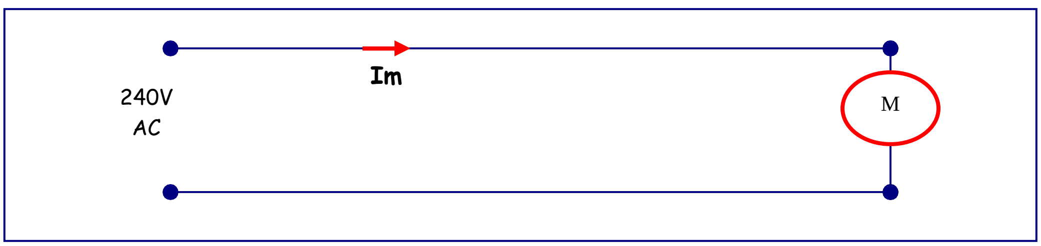

Figure 2: Circuit Diagram without insertion of Power Tune

e. Now, if we place the power tune (capacitance) in the first power point outlet of the power distribution circuit as shown in Figure 1, the circuit diagram becomes as shown below in Figure 3. The respective electrical phasor diagram is as shown in Figure 4.

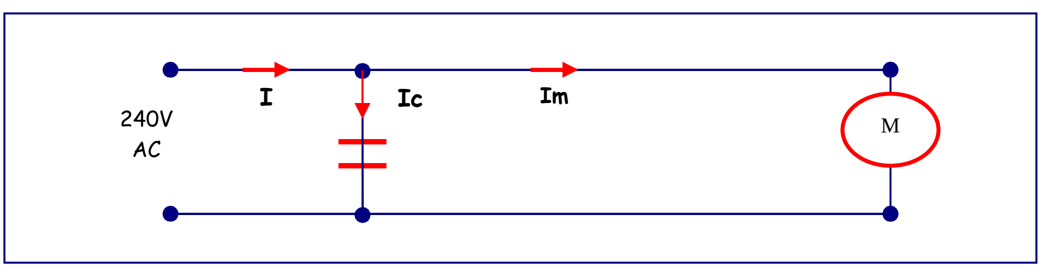

Figure 3: With Power Tune in Circuit (I = Ic + Im)

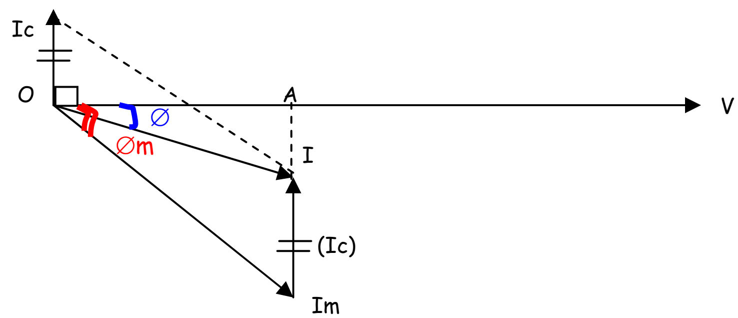

Figure 4: Electrical Phasor of Figure 3

f. Say, by placing the power tune, the power factor of the motor (M) is raised to 0.92 from 0.8 (cos ∅m)

g. Current Ic taken by the power tune must be such that when combined with Im, the resultant current I lags the supply voltage V by an angle ∅, where cos ∅ = 0.92.

From Figure 4,

Active component of Im = Im cos ∅m = 18.5 x 0.8 = 14.8 Amps (OA)
And
Active component of I = I cos ∅ = I x 0.92 (OA)

h. This component are represented by OA as in Figure 4,
Hence,

I x 0.92 = 14.8
I = 14.8 / 0.92 = 16.09 Amps

i. Reactive component of Im = Im sin ∅m = 18.5 sin∅m, where ∅m is $\cos^{-1}$ 0.8 = 36.9°, and therefore sin∅m = 0.6, leading to reactive component of

Im = 18.5 x 0.6 = 11.1 Amps ⟶ (1)

j. Reactive component of I = I sin∅ = 16.09 sin∅, where ∅ is $\cos^{-1}$ 0.92 = 23.0°, and therefore sin∅ = 0.39, leading to reactive component of

I = 16.9 x 0.39 = 6.30 Amps ⟶ (2)

k. Thus, from Figure 4 (of the phasor diagram) it will be seen that:

Ic = (reactive component of Im) – (reactive component of I)

Ic = 11.1 – 6.3 = 4.8 Amps ⟶ (3)

l. Capacitive Reactance (Xc):

$$Xc = \frac{1}{Wc} = \frac{1}{2\Pi fC}$$

Ic = V / Xc

Ic = 2ΠfCV

4.8 = 2 x 3.142 x 50 x *C* x 240

Therefore, *C*= 63.65 μF

m. From the above calculations, it will been seen that the effect of connecting the 63.65μF capacitor (Power –Tune) in parallel with the household loads of air-con is to reduce the current taken from the supply from 18.5A to 16.09A without reducing/altering the current taken or power taken by motor/loads.

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C. Conclusions

a. The calculations (as illustrated in this Paper with the aid of electrical phasor diagram) demonstrate the physics of the working principle of the so-called "Power-Tune", which is essentially power factor correction capacitor equipment.

b. The Power-Tune effectively reduces the current taken from the utility supply by a certain amount depending on the capacitor size of the equipment. Hence, a reduction in energy (kwh) consumption in the household fitted with the device.

c. It essentially provides a leading current injection phasor into the normally-lagging electrical loads.

d. For the illustrated case, an improvement in the power factor of 15% (i.e. from 0.80 to 0.92) results in 13% reduction in utility supply current (i.e. from 18.5A to 16.09A)

e. There is NO reduction in current / power taken by load themselves.

f. The equipment should be fitted "in front" of the inductive loads (such as air-cons, fridge, washing machine, etc.) in the power distribution circuit.