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Improved Efficiency Compressors for Household Refrigerators and Freezers

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IMPROVED EFFICIENCY COMPRESSORS FOR HOUSEHOLD REFRIGERATORS AND FREEZERS

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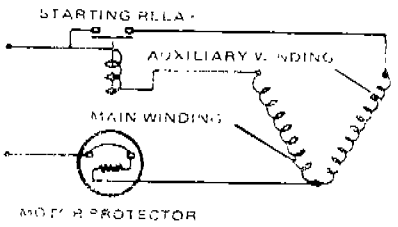
The new thinking is to save energy. So much so, that the government has intervened and told us to improve efficiencies on household appliances, i.e., the household refrigerator and freezer compressor. How can improvement in household refrigerator and/or freezers contribute to this energy conservation? When one considers the number of refrigerators and freezers in use today, any improvement in their operating efficiency would be very beneficial to the program of conserving energy. Today, let's discuss the hermetic motor used in these compressors. A typical third horsepower refrigeration compressor has a motor of the resistance start induction run design.



CONVENTIONAL ELECTRIC SYSTEM

This style motor has been used for years, with no major breakthrough on improving efficiencies. Many cost reductions has changed the compressor features, and it is very enlightening to look at equivalent capacity compressor of thirty years ago to today's compressor. One would get the idea that tremendous strides have been made and they have, but we can do better than that by new thinking, a new approach, a new style or design motor. This will permit us to keep our present size at slightly higher cost which would be quickly amortized by the reduction in utility bills that will result from the energy we save.

If we can go back to basic fundamentals, we know by definition that:

$$\frac{\text{Watts Output}}{\text{Watts Input}} \times 100 = \text{Efficiency in \%}$$

So, if we try our new approach to solve some energy saving, this is a good place to start. For a given horsepower motor, we must assume that the watts output demand on the motor will remain the same in designing a new motor. If we use a typical 1/3 horsepower motor in use today, we would conduct a dynamometer test and actually determine all the unknowns in the efficiency formula, but to expedite let me give them to you as

73% Efficiency at rated load
277 Watts Output at rated load
380 Watts Input at rated load

Now in any new venture, we know we need 277 watts output in the hermetic motor to do the job, therefore, let's assume we can design a motor with 80% efficiency. Now using our efficiency formula from above and substituting the knowns and the assumed values into the equation, it will look like this

$$\frac{277 \text{ Watts Output}}{X \text{ Watts Input}} = .80$$

This equation can be solved for watts input. We discover that an 80% efficient motor only requires 346 watts input to operate the compressor

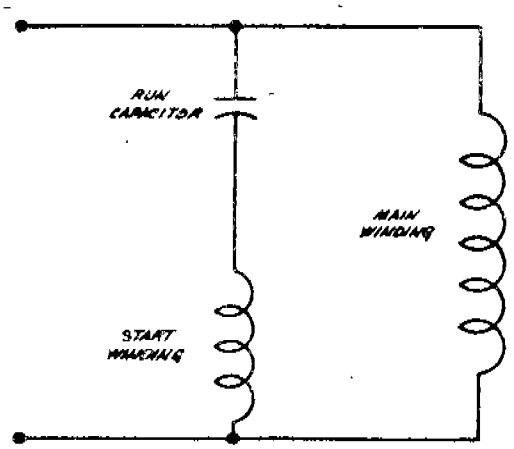
$$\frac{277}{.80} = \text{Watts Input}$$

$$346 = \text{Watts Input}$$

If we remember the 73% efficiency motor required 380 watts input to do the job, our new motor only requires 346 watts input.
The difference is

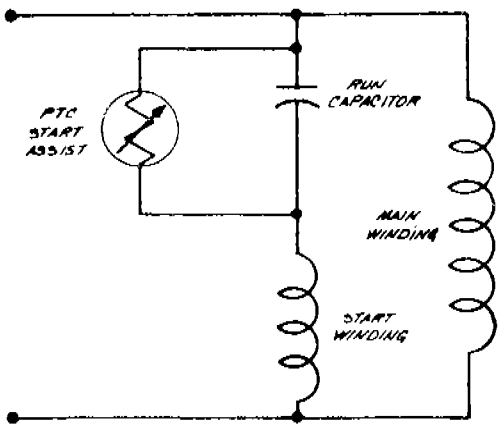
$$380 - 346 = 34 \text{ Watts}$$

If we can increase motor efficiency to 80%, we will have accomplished a 34 watt reduction. This is 8.8% better without any mechanical changes in compressor needed to do this. It is possible to get a motor with 80% efficiency. It is a new application for an old motor design PSC (Permanent Split Capacitor).



PSC MOTOR

There is one drawback in that the locked rotor torque of such a PSC design is too low. However, there is a new product on the market called PTC (Positive Temperature Coefficient) resistor. This PTC resistor basically is a resistor whose resistance changes several orders of magnitude when it reaches its design temperature. This resistor can be married to the run capacitor of the PSC motor such that we can enjoy the starting of the resistance start induction run motor and the efficiency of a PSC motor.



PSC MOTOR WITH PTC START ASSIST

The PTC material shorts out the run capacitor in the cold mode, but acts like a switch and throws the run capacitor back into the circuit when hot. A typical performance of a third horsepower compressor with the present and new type motors is tabulated for your evaluation.

This is an average of many compressors:

MOTOR TYPE (1/3 HORSEPOWER):	Present RS-IR	New PTCS-CR
Starting Torque (oz. ft.):	11	14
Locked Rotor Amperes @ 3 Sec.:	36	25
Efficiency @ Compressor F.L.:	73%	80%
Power Factor @ Comp. F.L.:	69.8%	83%
Cal. Watts Input @ Compr. F.L.:	380	330
Cal. Btu/Watts @ Compr. F.L.:	3.42	4.08
Cal. Capacity @ Compr. F.L.:	1298	1357
Cal. Amperes @ Compr. F.L.:	4.82	3.48
On Cal., a 13.1% reduction in watts		

PERFORMANCE IN A TYPICAL CAB.:	Present	New
Peak Motor Temperature:	256°F	240°F
Ult. Low Motor Temperature:	245°F	234°F
Ult. Low Watts:	370	330
Ult. Low Amperes:	4.58	3.35
Maximum Pulldown Watts:	454	412
Maximum Pulldown Amperes:	5.15	4.08
Power Consumption KWH/Day:	5.06	4.455
In Cab., a 12.1% reduction in power consumption		

Please note many advantages of the new PTCS-CR motor:

1. Increased Starting Torque.
2. Much lower L.R.A. less voltage sag on startup.
3. Improved efficiency.
4. Better P.F. (the utilities will love this).
5. Less watts input at F.L. (this is better than calculated). We actually got a 50 watt reduction, not 34 watts as calculated. The better than expected watt reduction is probably side effects of the higher efficiency such as lower operating temperature, less I^2R loss, less core loss, etc., which accumulates to give us another 16 watts improvement.
6. Please note the improved Btu/W without any mechanical changes.
7. Please note the improved performance in a typical cabinet.

FOR EXAMPLE:

Cooler motor, lower watts input and lower current.

Again, I will stress these improvements have been made by the electric motor only. No mechanical changes have been made. Mechanical changes, I assume, will be the second phase of this program.

In conclusion, Gentlemen, if I may get a little philosophical - Gone are the days when we could assume we had unlimited energy. Organize your thinking to

1. Better Btu/Watt performance.
2. Let's take the initiative, with no government intervention, to conserve energy.
3. Understand the problems of the future if we do not start saving energy now!
4. Educate the public to purchase the products that saves energy.