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ABSTRACT

MINIATURIZATION OF THE FREON COMPRESSOR: THE BELLOWS PUMP

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All indicators point to the decade of the 1980's as the years of conservation. Whatever
the technological "fix" of the future that will bring endless and sufficient energy
supplies, if one exists, it will not be available within this time framework. Conserva-
tion is the only immediate answer to maintain energy requirements within increasingly
strict guidelines.

Conservation comes in two packages. There is the conservation of curtailment; simply
doing without. Turning back the thermostat and reducing the mileage traveled are the
two most popular examples. The second package is far more exciting to engineers. It is
conservation by innovation; accomplishing the same task but using less energy. Insulating
and improving EER's are two well known examples.

Some argue that these initial attempts at efficiency improvement are just the tip of the
iceberg. In many cases, total redesign of energy-consuming devices with the ideal goal
of zero energy use may in fact create machines that use one-fifth to one-tenth of the
power of their predecessors. In the domestic appliance sector, the commercially successful
example of this redesign is the microwave oven; accomplishing the same goals as the
conventional oven but at one-quarter of the power. A household refrigerator that can
reduce operating expense up to eightfold has already been projected.

Although these future concepts are welcomed, they imply far-reaching consequences for
refrigeration component manufacturers. For example, if the present refrigerator is
powered by a 1/4 hp compressor and the future model will cut this load by eight times,
this implies that a 1/32 hp compressor must be in the offing. Yet the conventional
reciprocating compressor does not lend itself to economical miniaturization. This is
best evidenced by comparing the present cost of a 1/6 hp hermetic compressor with that
of a 1/12 hp unit. The price is almost the same.

Yet who is to say that the reciprocating concept is the best alternative for these
microminiature models. The University of Toledo Climate Control Laboratory is attempting
to identify an economical alternative design with the goal of having a 1/32 hp model fit
in the palm of your hand and sell at retail for less than $20.00. This report documents
one such concept.

The Bellows Compressor: Very small air compressors often operate on the principle of the
bellows. A bellows is a chamber whose volume can be readily increased or decreased. It
is made of a synthetic material which expands and contracts causing suction and pressure.
Often it is referred to as a vibrating pump. The vibrations are created by the push and
pull of an electromagnet. This takes the place of a motor. Pumps of this type are as
small as a fish tank aerator, or industrially, can run over ten hp.

There adaptability to freon compression systems is documented in the full paper. A
survey of the characteristics of commercially available bellows pumps is followed by
discussion of the pressure differences achievable by the bellows concept. Suggestions
of modifications in design and alternative refrigerants are made to achieve a viable
product.

The difficult question of whether any bellows material can stand up to the chemical
attack of refrigerants for extended periods of time under undesirable temperatures is
investigated. Finally, efficiency measurements are made to determine whether the bellows
trades off low initial cost for high operating expense.