Cooling concepts for year 2000 and beyond!

"...cooling systems of the past become very primitive when adapted to today's modern engines..."

Electric Fan's technology leader Roger Clemente has new ideas for "cooling off" modern heat producers.

... see page 188

Reprinted from a feature article in IVT '98 (Industrial Vehicle Technology) Magazine.
Cooling concepts on the horizon

Modern off-highway vehicles place an overwhelming demand for advanced design cooling systems that can ensure maximum operating efficiency. Such complex systems must be able to effectively cool a number of different fluids. The use of electric and hydraulic fan assemblies on traditional heat exchangers will provide an effective alternative in the design of cooling systems that will reduce noise and emissions and increase overall performance.

Roger Clemente, Electric Fan Engineering, USA

The cooling systems of the past become very primitive when adapted to today's modern engines, since manufacturers are now required to design complicated cooling systems to control the temperature of many fluids, including water, oil, freon, charged air and even diesel fuel. Such sophisticated cooling requirements can place an overwhelming demand on all types of belt-driven fan systems, including on/off assemblies, since they can consume up to 15 per cent of the engine's available horsepower when operating at high peak loads.

Another drawback is that they reduce overall performance and efficiency, because such fan assemblies have great difficulty in correctly monitoring and maintaining the multiple operating temperature levels of a radiator when combined with the many other different types of heat exchangers necessary to support other engine functions. Obviously, each assembly has its own unique cooling requirements. For example, an air-conditioning condenser may require fan operation while other systems do not. It is no longer practical to use a single fan system to properly cool an assortment of heat exchangers that are grouped together.

For many years, these traditional systems found on both stationary and mobile applica-
tions have remained virtually unchanged and are now considered to be very inefficient and a costly component to maintain. More importantly, they restrict the overall design of the vehicle or machine since the fan must be attached directly to the engine.

Belt-driven fan systems, commonly found on most mobile applications, including on-road vehicles, are required only 5 to 10 percent of the time when idling, moving at slow speeds or climbing steep grades. At other times, the forward movement of the vehicle at speeds in excess of 20-30mph is sufficient to provide the necessary airflow through the radiator to maintain proper operating temperature. On other types of stationary, off-highway and industrial applications they create packaging restrictions, which may result in noise abatement issues.

Recent product developments will provide OEMs with several new methods to aid design of complex cooling systems. The combination of sophisticated electric or hydraulic fan technology with related heat exchanger components will ultimately aid the engineer in developing the necessary high-performance cooling products to meet tomorrow’s challenges and set new goals and standards for the industry to meet.

These assemblies, which operate only when necessary, from the 12 or 24V electrical system, have proven their merit in the aftermarket and are now rapidly gaining recognition from various manufacturers.

The advantages of electric fans are numerous. When used on many auxiliary applications, electric fans can provide additional airflow to prevent overheating, supplement the existing belt-driven fan as a new means to control unacceptable noise levels and aid in the redesign of the engine compartment by relocating heat exchangers.

On select primary cooling applications, electric fans with an adequate capacity may also be used to replace the conventional belt system (Figure 2). Most on-road vehicles that benefit from ram-air-cooling can accept such modifications provided they have engines under 400hp and that the temperature levels of all appropriate systems, including water, oil and charged air, as well as air-conditioning heat pressure, are monitored. In addition, other types of off-highway or stationary vehicles with engines up to 1000hp can be adapted to make use of electric fans for primary cooling provided they have adequate alternator capacity, since such fans consume large amounts of electrical power (Figure 3). It should be noted that successful installations rely on many critical factors including gross vehicle weight and proper radiator core size.

**Going hydraulic**

Hydraulic fans are designed for extremely difficult cooling applications that are commonly found on both stationary and off-highway vehicles (Figures 4 and 5). On such installations, the conventional belt system on engines in excess of 1,000hp can easily be replaced with hydraulic fans even though they do not benefit from ram air cooling.

Fundamentally, this replacement will surpass previous original equipment standards since it provides an improved method to control temperature, permit remote mounting of heat exchangers, aid in noise and vibration reduction, allow use of multiple fans and, more importantly, provide more air flow than a conventional system, since the speed of the fan can be

---

**About Electric Fan Engineering**

Electric Fan Engineering was founded by Roger Clemente in 1972. It has become a leader in pioneering and developing numerous patented cooling components, which include battery-operated turbine electric fans, hydraulically driven turbine hydraulic fans and the thermal max summer/winter fluid heat transfer system. In addition, it is recognized for many industry firsts, including:

- The first to pioneer the use of 'S' shaped electric fans for cooling automotive engines;
- Originated the use of turbine electric fans to cool transit buses;
- Successfully developed and patented the turbine hydraulic fan system for heavy duty cooling applications;
- The first to perfect and patent the use of turbine electric fans for on-road trucks;
- A major consultant and supplier to many Fortune 500 OEMs in addition to the US military;
- The innovator of the patented thermal max summer/winter heat transfer system to control the year round temperature level of diesel fuel;
- The only worldwide manufacturer to offer large-diameter 12 and 24V cooling fans.
trolled in a number of ways. The simplest are electric control valves between the pump and fan or a patented method that has an electric clutch directly mounted to the pump. At a predetermined temperature the first assembly opens a solenoid valve, energizing the fan motor. In contrast, the second assembly engages the clutch when necessary, starting the pump in operation, which in turn energizes the motor for the fan. When a lower temperature is reached, a signal is sent to both systems stopping the fan. The electric clutch type is preferred because it reduces maintenance costs as the internal components of the pump rotate only when necessary.

Depending on the quantity, the economics of a typical hydraulic fan system for a 400hp engine system can be very favorable since the cost of major componentry is approximately US$650.

A manufacturer can combine electric or hydraulic fans with many different types of heat exchangers, allowing an engineer to easily reshape a vehicle’s structure by remote mounting such assemblies away from congested areas to alternative positions.

**Multifunctional heat exchangers**

Most types of fluids (oil and water for example) have different cooling requirements. On special applications, multifunctional heat exchangers may be required to safely monitor the preferred year round temperature level of a fluid. Diesel fuel, for instance, must be heated in the winter and cooled during the summer as a means to control pressure, droplet size and density, which are all critical factors in governing emissions and engine performance. In certain instances, the use of climate-controlled air produced by a vehicle heating/air-conditioning system will allow an assembly to do both.

One patented multifunctional system (Figure 6) currently available operates in the following manner. A remote mount heat exchanger is connected by ductwork to a vehicle’s cab compartment. As diesel fuel is circulated internally through the heat exchanger, climate-controlled air produced by the vehicle’s heating and air-conditioning system from inside the cab compartment is drawn and passed externally over it. During the winter, warm air from the heater is used to heat the fuel while the climate-controlled air produced by the air-conditioning system is used to cool the fuel during the summer. Obviously, the volume of air that can be removed is limited to the capacity of the system, however, such designs can provide better heat transfer since they are not dependent on the outside ambient air.

Improvements in thermal management will allow manufacturers and engineers to develop cooling system designs that reduce vibration, eliminate fan alignment problems, allow radiators and other types of heat exchangers to be relocated away from congested areas, help reduce engine compartment overcrowding and prevent overheating by supplementing existing systems. In addition, these systems will assist in better weight distribution and provide new means to control noise levels.

OEMs who pioneer new concepts by using state-of-the-art componentry will undoubtedly have the competitive edge in the marketplace.