FEDERAL SIGNAL
Safety and Security Systems
Protecting people and our planet

Industrial Technology:
Overcoming Mechanical Failures in Industrial Horns and Sounders

Abstract

Electromechanical horns, sirens and other sounders have been integral fixtures in and around commercial and industrial facilities for decades. These audible devices produce loud clear tones used in a variety of applications within manufacturing facilities, schools, office buildings, and sporting arenas to name a few. However, the mechanical actuators used in these devices have certain limitations.

Limitations include:

- Restricted duty cycle requiring the unit to be cycled on and off to prevent premature failure.
- They are prone to mechanical failure because of the rapidly moving parts.
- Higher drive current is necessary to move the mechanical actuator, and they have minimal tone flexibility and limited sound output adjustment.

This paper will discuss several types of electromechanical horns and sirens as well as how the advancements in electronic horns and sirens have overcome mechanical limitations or their predecessors while producing the same loud, rich, clear tones.

Understanding the Current Technology

The following is a brief description of the types and functionality of the various signaling devices.

Electromechanical Siren

A traditional electromechanical siren utilizes a spinning rotor, effectively a fan, driven by an electric motor inside of a stator. The stator is an enclosure with a series of holes or gaps located around the parameter (see figure 1 & 2). As the rotor spins it draws air in through the center of the device and forces it out through the gaps in the stator. This puffing or chopping of the air through the gaps produces sound waves at a specific tone and at a given volume or sound pressure level (SPL). The size of the components, the rotor and stator, and the speed at which it spins; combined with the projector that directs the sound waves produces a specific tone and volume. With the fixed size and spacing of the components the only common variable is the rotation speed of the rotor.

Therefore, the siren running continuously will produce a steady tone or continuous blast. If the drive motor is alternated on and off varying the speed of the motor, a siren can produce a series of effects such as a wail, a slow rising and falling of the tone.

As with any moving mechanical component, there are several possibilities for failure:

- The rotor and stator are vulnerable to intrusion of dirt or other environmental debris causing wear on the parts or possible unbalance.
- If the rotor spins out of balance, it often contacts the stator causing damage and ultimate failure of the device.
- Intrusion of water will cause the components to corrode or rust.
- The drive mechanism that spins the rotor is traditionally a standard electric motor. This type of motor typically has higher current draw and the inherent failure points of any electric motor.

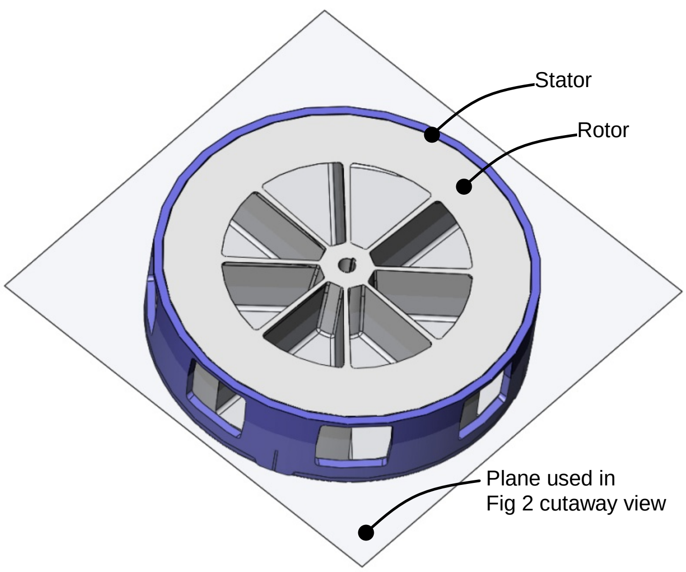

Fig 1: Rotor and stator in a typical electromechanical siren

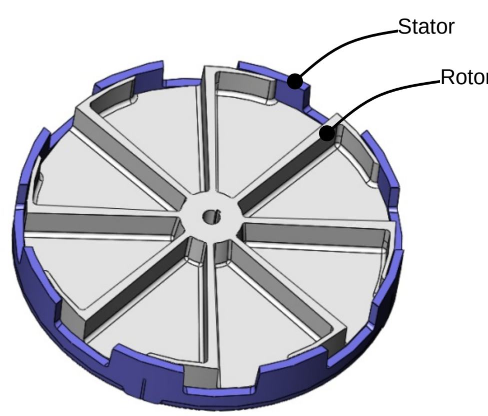

Fig 2: Cutaway view of mechanism in Fig 1

Electromechanical Horn

Common electromechanical horns utilize a complex system of magnets, contacts, springs and a diaphragm all connected by a mechanical shaft (see figure 3 &4). The drive mechanism in this horn rapidly flexes a diaphragm back and forth, pushing the air in front of it and creating sound waves. Illustrated in the diagram below (Fig 3.1), when power is applied and the circuit is complete at the contacts, power is transferred to an electromagnet (Fig 3.2). This energizes the magnet and draws the armature down toward the magnet, flexing the diaphragm via the shaft (Fig 4.1). At the same time the electrical contact is broken (Fig 4.2), de-energizing the electromagnet and allowing the internal spring to return the shaft to the starting position. The electronic contact is reconnected (Fig 3.1) and the cycle begins again. This cycle can repeat over 300 times per second.

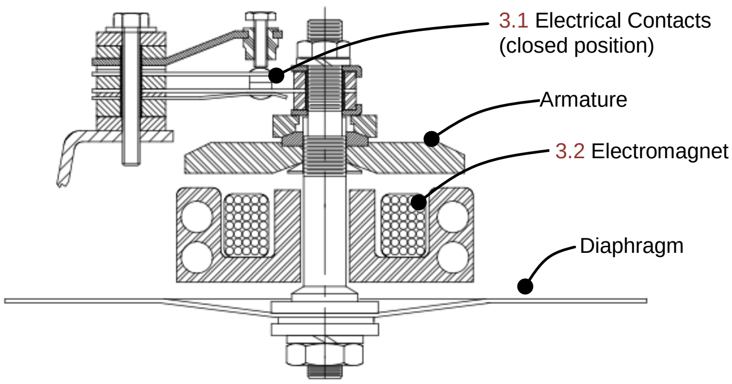

Fig 3: Electromechanical horn mechanism in an unpowered state

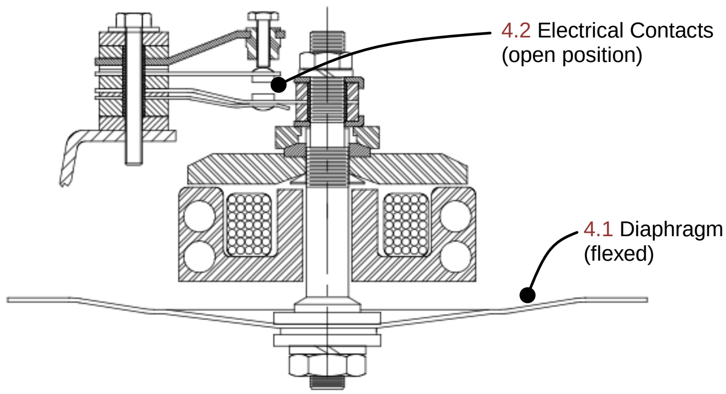

Fig 4: Electromechanical horn mechanism in a powered state (armature has reached lower travel limit)

The repeated flexing of the diaphragm pushes against the air in front of the diaphragm creating pulsing air waves thus producing the sound waves. Many factors affect the tone and volume (SPL) of an electromechanical horn. These include the diameter, thickness and materials of the diaphragm, and the shape and length of the horn/projector. The frequency at which the diaphragm flexes significantly affects the final output. Similar to the electromechanical siren, horns are typically a single tone and single SPL per device. Variation in the signaling capability can be achieved through coded blasts, a series of blasts followed by periods of silence that is similar in concept to Morse code. The complicated nature of the mechanism contributes to a limited duty cycle and potential mechanical failure points that include corroded contact points, cracked diaphragms and broken springs.

Electronic Horn & Siren

The new Federal Signal eHorn and eSiren overcomes all the issues inherent to the electromechanical devices by eliminating a required duty cycle, significantly lower operating current, minimizing mechanical vulnerability and significantly expanding the signal's flexibility through multiple tones and volume settings. These new electronic horns (Fig 5) and sirens utilizes a patent pending microprocessor based tone generating technology to generate a frequency that is transmitted to an electronic speaker coil. The coil stimulates the robust speaker diaphragm, causing it to vibrate and create and transmit sound waves in the air and through the reentrant horn. This produces the desired sound waves that correspond to a desired tone.

This robust proven diaphragm is the only moving part of this device, eliminating a required duty cycle and increasing the horn's reliability. With no electric motors or electromagnet actuator required to drive the diaphragm, the new Federal Signal eHorn and eSiren require only 0.03 to 3.3 amps depending on the model and operating voltage.

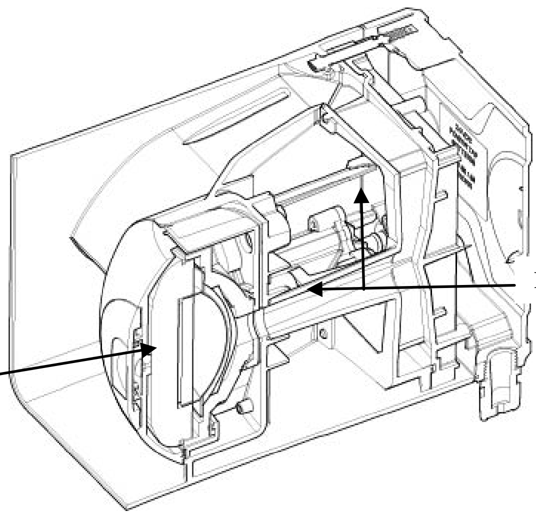

Fig 5: Electronic Horn and Siren utilizes speaker driver and reentrant horn

Federal Signal's eHorn and eSiren are equipped with two onboard field selectable tones. The eHorn replicates the standard Federal Signal 52 or 55/56 horns with three selectable volume outputs ranging from 100 to 117 dB, depending on tone and operating voltage. The eSiren replicates the traditional Federal Signal Model A or L siren. Additionally, the eSiren features three selectable volume outputs ranging from 104 to 115 dB, depending on the tone selected and operating voltage.

The new eHorn and eSiren are UL and cUL listed and carry the UL Marine rating. Additional benefits of the Federal Signal eHorn and eSiren include corrosion resistant glass reinforced polycarbonate housing that provides a Type 4X, IP66 enclosure. The stainless steel mounting brackets and hardware are both durable and corrosion resistant, as well as, offer a variety of mounting options. These new electronic signaling devices are suited for indoor and outdoor applications.

The Federal Signal eHorn and eSiren devices are more reliable, flexible and durable. The use of the patent pending sound generation technology paired with time tested components come together to produce a superior product. By eliminating moving parts, Federal Signal has produced a durable and reliable signal device.

The advanced electronics provide greater flexibility of the device by offering multiple field selectable tones and volume settings in a single unit. The advance materials used for the housing and time tested stainless steel brackets and hardware allow this equipment to function reliably in an array of polluted, damaging or corrosive environments. The eHorn and eSiren provide a superior solution in a wide variety of industrial applications.

For more information visit the Federal Signal website, http://www.federalsignal-indust.com/

