AIO

Online Technical Resource

Direct Pallet Magnets,
All- Electric Chest Action

by Ross King

Summary:

1. All-electric is faster than electropneumatic, both in attack and repetition. In general, pitman e-p is the slowest, unit e-p is faster, and all-electric is fastest.

2. Pipes speak with the same enunciation (attack) on all-electric chests as they do on a small tracker chest when the tracker keys are struck sharply.

3. The margin of error with all-electric valves is pretty small because the magnets are not very powerful.

4. If an all electric valve is slow in opening, it is not sufficiently powerful. There are four ways to increase speed: Increase the voltage, lower the wind pressure, decrease the size of the chest boring, or use a stronger (lower ohmage) magnet. (Dennis Milnar adds: a fifth way is to adjust the magnet armature closer to the pole piece.)

Chest hole diamter is very important: The load on a magnet varies directly with the area, not the diameter, of the chest hole. That is, the load varies according to the square of the diamter, not just the diameter itself. (Area of a hole = pi times the radius squared = pi times one half the diameter squared.) For example, the area of a 1/2" diameter chest hole is 0.1963 square inches, the area of a 3/4" diameter chest hole is 0.4416 square inches. 0.4416 is 2.25 times greater than 0.1963. Therefore, it takes 2.25 times more power to open the pallet over a 3/4" chest hole than over a 1/2" chest hole. Here's a shortcut method for comparing the areas of holes: square the relationship between diameters rather than figuring out the areas of the holes. For example, the diameter of a 3/4" hole is 1.5 times that of a 1/2" hole. 1.5 squared is 2.25.

Regarding voltage: Magnet power is directly proportional to voltage. Raising voltage from 10 to 12 volts yields a 20 percent increase in power.

Regarding recitifiers and voltage: Older all-electric chests likely tested faster than those today because modern power supplies don't put out as much voltage in the kind of low load, one note single pipe situations in which the speed of attack and repetition are tested. Explanation: There are two kinds of recitifiers available today: the massive transformer type (OSI) and transistor regulated small-transformer type (Astron). Older massive transformer type rectifiers had poor voltage regulation. If the label read "30 Amp", and if the tap was set at 12 volts, the rectifier would indeed supply 12 volts when the load was increased to 30 amps. But at lighter loads, the voltage output was considerably higher, say, 18 or more- enough to make a magnet operate very quickly. A modern ferro-resonant rectifier puts out the voltage indicated on the tap. That is, if the tap is set on 12 volts, it puts out pretty close to 12 volts regardless of load. The

same is true of Astron rectifiers. An Astron rectifier can be modified internally by changing a couple of resistors in the regulator circuitry to cause it to put out something like 18 volts- at a reduced amperage capacity, of course.

Regarding relays, cables, and voltage: Solid state relays have an internal voltage drop of about 1.4 volts. That is, if 12 volts is fed into the relay, only about 10.6 volts come out. Older electromagnet relays such as the ones by Reisner and Klann do not have such a drop. We plan on an additional loss of about 1.5 volts due to resistance in the cables under full load conditions. Summary: The recitifier puts out 12 volts, the relay in turn puts out 10.6 volts (12- 1.4 loss in the switching system = 10.6 volts). The magnet gets 10.6 when only one note is played, 9.1 when a big chord is played on full organ (10.6- 1.5 loss in the cables under full load = 9.1 volts.).

Is it possible for a pallet magnet to open slowly, or is an either/or situation, open or not open?...Yes, a pallet magent opens slowly if it is underpowered- the voltage being too low, the magnet being too small, the pallet being too large, the pressure being too high, etc. Such a condition is more apparent with reed pipes than with flue pipes (see below).

Do flue pipes speak sooner than reeds on all-electric chests?...Yes, sometimes, if the magnets are underpowered. A flue pipe begins to speak as soon as wind begins arriving at the languid. Therefore, if a pallet opens slowly, the flue pipe begins to speak when the pallet begins to open. A reed pipe, however, does not want to speak until full wind pressure is reached at the tongue. So, if a pallet opens slowly, the reed pipe does not begin to speak until the pallet is fully open. This phenomenon occurs because the chest holes for mid range and treble reed pipes are so much larger than for flue pipes. The typical chest hole for a 2' reed pipe may be 3/4" diameter, a hole whose area is four times that of a typical 3/8" toehole for a 2' flue pipe. It would make sense to have a reverse counterbore for reeds- that is, to have the pallet cover a 3/8" toe board hole (so long as the toe hole in the reed boot was smaller than 3/8"), even though the hole at the top of the toe board would need to be 3/4" to accomidate the reed boot tip. (Editorial clarification: this would ensure that all of the magnets in that range were opening the same area hole, so they would all be seeing the same load, regardless of whether there was a reed or a flue pipe.)

How far should the pallet open?...A simple but useful answer: far enough to let enough wind in, but not so far that it slams on release. A pallet opens the same area as the hole above it if the pallet moves 1/4 of the diameter of the hole. If a pallet magnet moves 3/16", measured at the center of the hole, it is useful for a chest hole up to four times 3/16", or 3/4"- theoretical, that is, assuming that the wind has no resistance to turning a corner. Actually, the maximum useful hole diamter is more like 5/8". Large pipes sound windy if the pallet doesn't open far enough. This is because the wind creates turbulence passing around the pallet and turning the corner up into the toe board boring. To overcome this problem, we use double valves or e-p action for large pipes, larger than 6', for example. We adjust magnets so that the pallets open no more than necessary. Since they must traverse the same distance when closing, the greater that distance, the greater the velocity, the more slamming when the note is released.

Adjustment of lever-type magnets: Magnets have the most power when the tip of the armature is about 10 percent over the face of the magnet pole piece. Since a magnet needs power most at the point when the pallet is first opening, we adjust the armatures to be at that 10 percent point when the pallet is closed.

Does it hurt to use an overly large pallet?...In theory, it is only the size of the chest

boring that affects power. In theory, therefore, magnet response doesn't change if a large pallet is used for a small hole. In practice, however, since the felt and leather valve tends to cup a bit as it opens, resistance does increase a small amount, say 10 to 20 percent with a large pallet.

The value of counterboring?...I can't see it. For one thing, a counterbore increases the size of the hole the pallet covers, and that increases the load on the magnet. And what does counterboring gain? The small volume of the counterbore is negligible compared to the volume of a pipe foot. If increasing the volume between the pallet and the flue improves speech, use longer pipe feet.

Chris Nagorka adds: I disagree with the premise of this article, as stated in the summary. When one looks at the moving mass involved with all electric action, the idea of saying it has the highest repetition rates doesn't stand up to physics. Not only does the relatively large electromagnet take a long time to build up its magnetic force, but then a piece of steel has to respond to that charge, pull the valve away from the toeboard, and bring the whole assembly to a stop with each cycle of the note. On electro-pneumatic chests, the moving mass is limited to the magnet armature, which has much less area to travel, and the pouch valve, which doesn't weigh as much as the armature and valve assembly on an electric action magnet. It also needs to be kept in mind that electropneumatic action speeds up as the wind pressure increases, where electric action slows down. With regard to the mention of Astron rectifiers, the models with out meters on the front are factory set at 13.8 volts. There is a potentiometer inside the cabinet which changes the voltage at the output from about 10 to up to approximately 15 volts. Note that the maximum permissible DC control voltage allowed by the National Electrical Code is 15 volts. Having the magnets recieving 9 volts under full load hasn't worked for me; many of them went dead, but this was on 5" and 6" wind pressure. Figuring a volt a a half of loss in cables strikes me as somewhat excessive; this would only take place in cable runs of several hundred feet (when using number 24 telephone cable).