Eureka-style grain cleaners – air flow through a typical unit

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The S Howes Company of Silver Creek, New York manufactured the "Eureka" type grain cleaning machines. Numerous examples of this machine exist in the UK. After we studied the construction of some of these machines, we thought it might be useful to offer some conclusions on the air flow through a typical unit.

These machines were widely copied by other engineering firms and also made under licence. They exist in various forms, often as scourers, smutters, and separators, or brush and finishing machines. The various constructions tend to share similar air flow routes and purpose with regard to the function of the air flowing through them. Figure 1 (*right*) shows a typical Eureka grain cleaner unit that we shall consider.

Courtesy of Crabble Corn Mill, Kent

This machine utilises air currents to remove from the grain both dust and other impurities such as chaff, straw, shriveled grains and so on. The construction of the machine to be considered has a 'smutter section' as well as an initial screening stage via shaking perforated metal sieves.

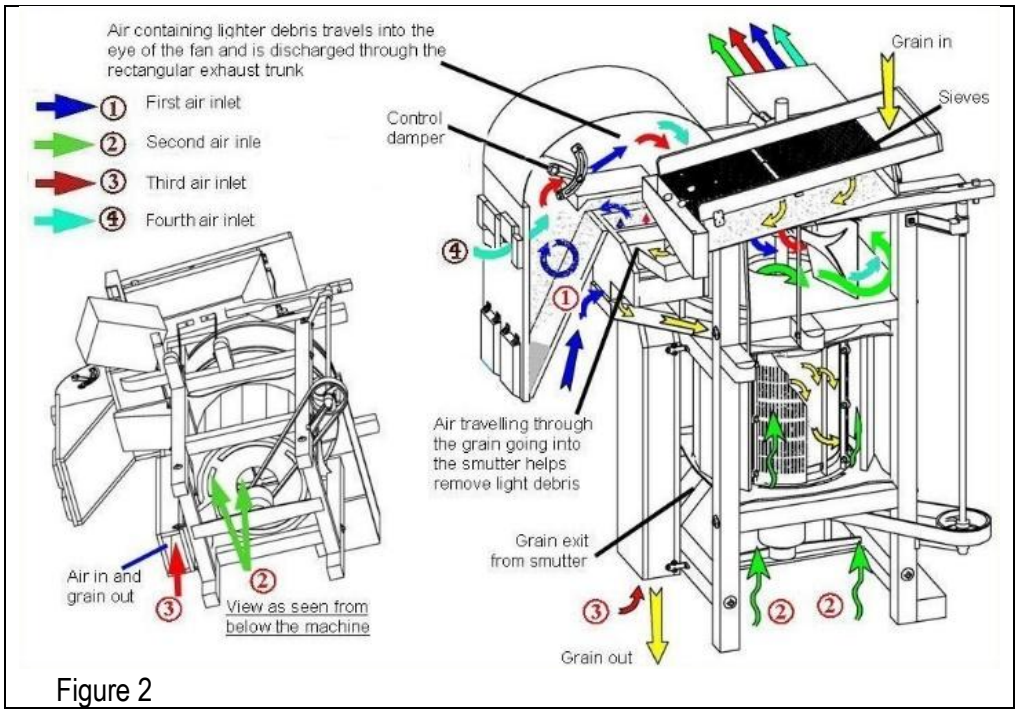
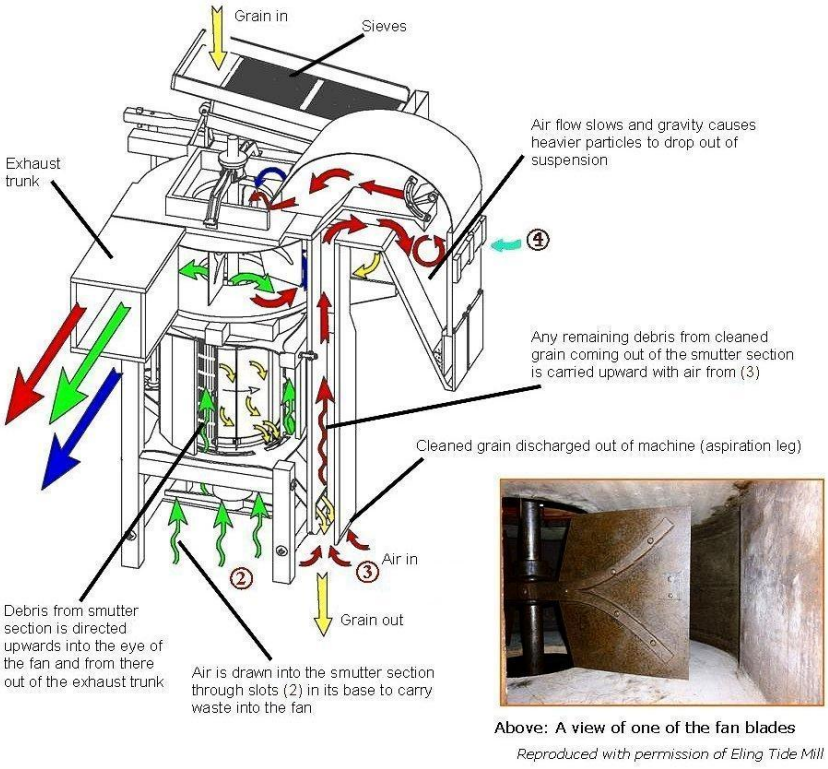


Figure 2

There are four air circuits (one being variable) that take place, before, during, and after the smutter section. The air flow circuits look fairly complicated as shown in figures 2 and 3, which are three-dimensional views of the air flows.

This arrangement appears to be a typical arrangement although there are noted to be some differences depending on the model and type of machine.



Above: A view of one of the fan blades

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Figure 3

At the heart of the Eureka is a large fan, an example of an actual fan blade can be seen in the picture in figure 3, these are fairly large and flat. The air pressure just at the entrance to the fan will be the lowest in the machine and will be at atmospheric pressure at the inlets ①, ②, ③, and ④. The fan acts as a form of compressor and on its outlet side it discharges to atmospheric pressure in the exhaust trunk.

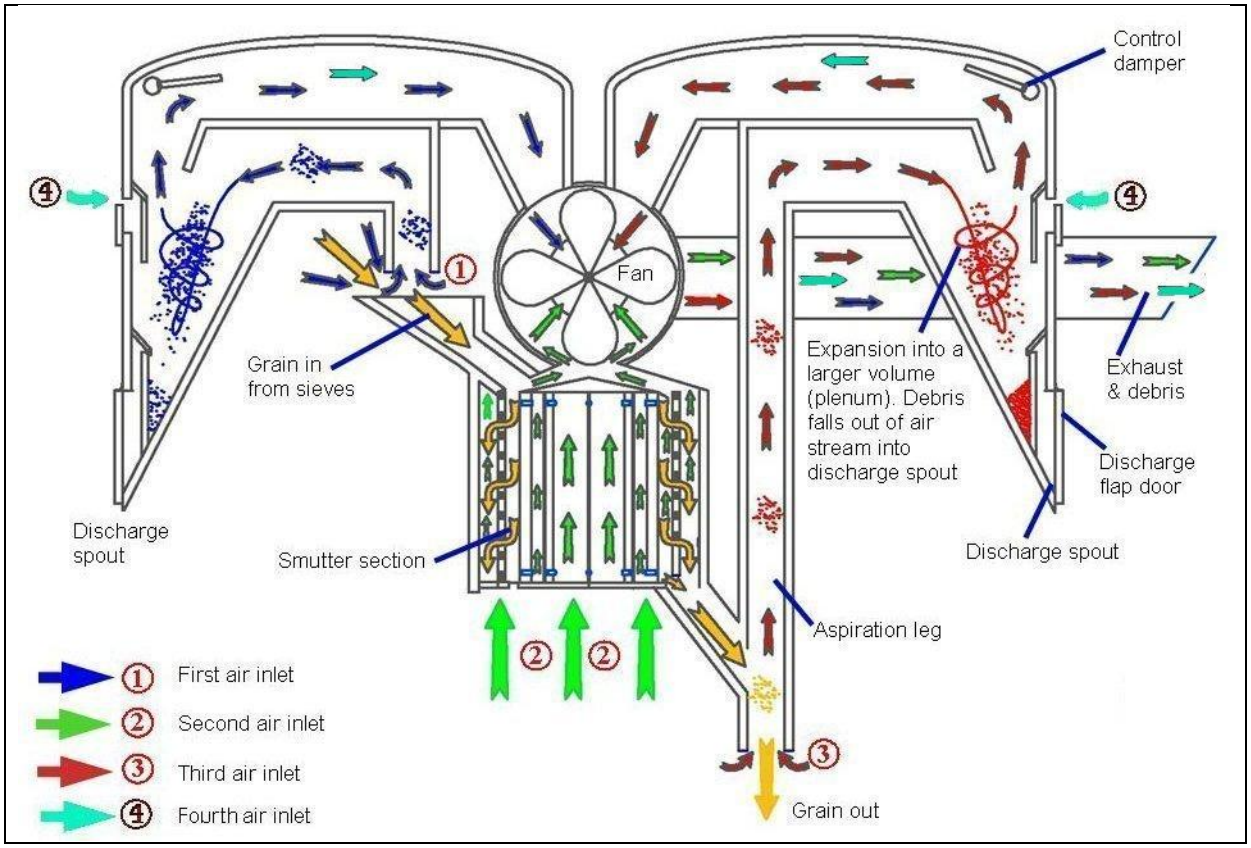

Figure 4 (*above*) is a simplified schematic showing the route of the air circuits. (This schematic does not include the layout of the shaking sieves.) Note the aspiration legs. Aspiration, or separation by ascending air currents is used to remove light particles from the grain. The principle involved is that particles of different size, shape and specific gravity have different "terminal velocities". Examples of terminal velocities are given by Lockwood[1], for example. 500 to 700ft per min for chaff, 700 to 1200ft per min for light straw and seeds, and

1150 to 1930ft per min for wheat. Wheat has a higher terminal velocity than light impurities, so that if a mixture of wheat and light impurities is dropped into an air current rising at a suitable speed the wheat will fall through it and the light particles will be borne away.

A particular feature of Eureka machines is the expansion chambers or plenums. There are two of these being vertically separated and alongside each other in the triangular shaped section. As the air containing debris is drawn from the duct (or channel) into the expansion volume the air flow slows. Solids being carried by the air tend to fall out of suspension and fall into the tapered discharge spout in the bottom of the chamber. Control dampers are provided to adjust the air throughput.

The debris, which falls into the discharge spout, remains there until the weight of the accumulated debris exceeds the force of atmospheric pressure on the doors of the spout – see figure 5 – whereupon it falls out of the spout. Also shown in figure 5 are the two air inlet slides (marked 'A'). These vary the amount of air that can be admitted to the plenum. If used, air entering the machine here assists in the removal of light debris from the plenums towards the fan.

Figure 5: The discharge flap doors and air inlet sliders (marked 'A') on the discharge trunk

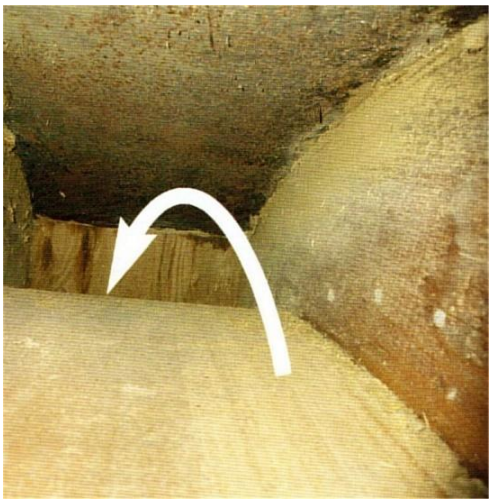

Figure 6: A view inside one of the two air ducts above the plenum.

Both photos Courtesy of Ifield Watermill, West Sussex

Figure 6 shows a view inside one of the two air ducts above the plenum. Note the smooth curving roof and bottom of the channel. Curves, rather than abrupt right angle bends, help reduce irregularity in the air flow. The highest air flow will be in the centre of the duct with the lowest at the sides due to drag (friction) with contact along the walls.

Note that the drawings have been based on information obtained from various sources (see for example references [2] to [5]), and via external inspection of various machines. However, both John and I would welcome sight of any photographs that show internal details.

References:

[1] Lockwood, J F (1945), *Flour Milling*. The Northern Publishing Co Ltd

[2] Greey, W & J G (1901), *Greey Toronto Mill Furnishing Works: Illustrated Catalogue* p43 to 45

[3] Robertella, L (2013),
http:/www.lousweb.com/Castle%20Valley%20Mill/eureka_brush_machine.htm
and private communications.

[4] Voller, W R (1892), *Modern Flour Milling* p53 and 79. John Bellows.

[5] Grimshaw, R. (1882), *The Miller, Millwright and Mill Furnisher* p275. Howard Lockwood