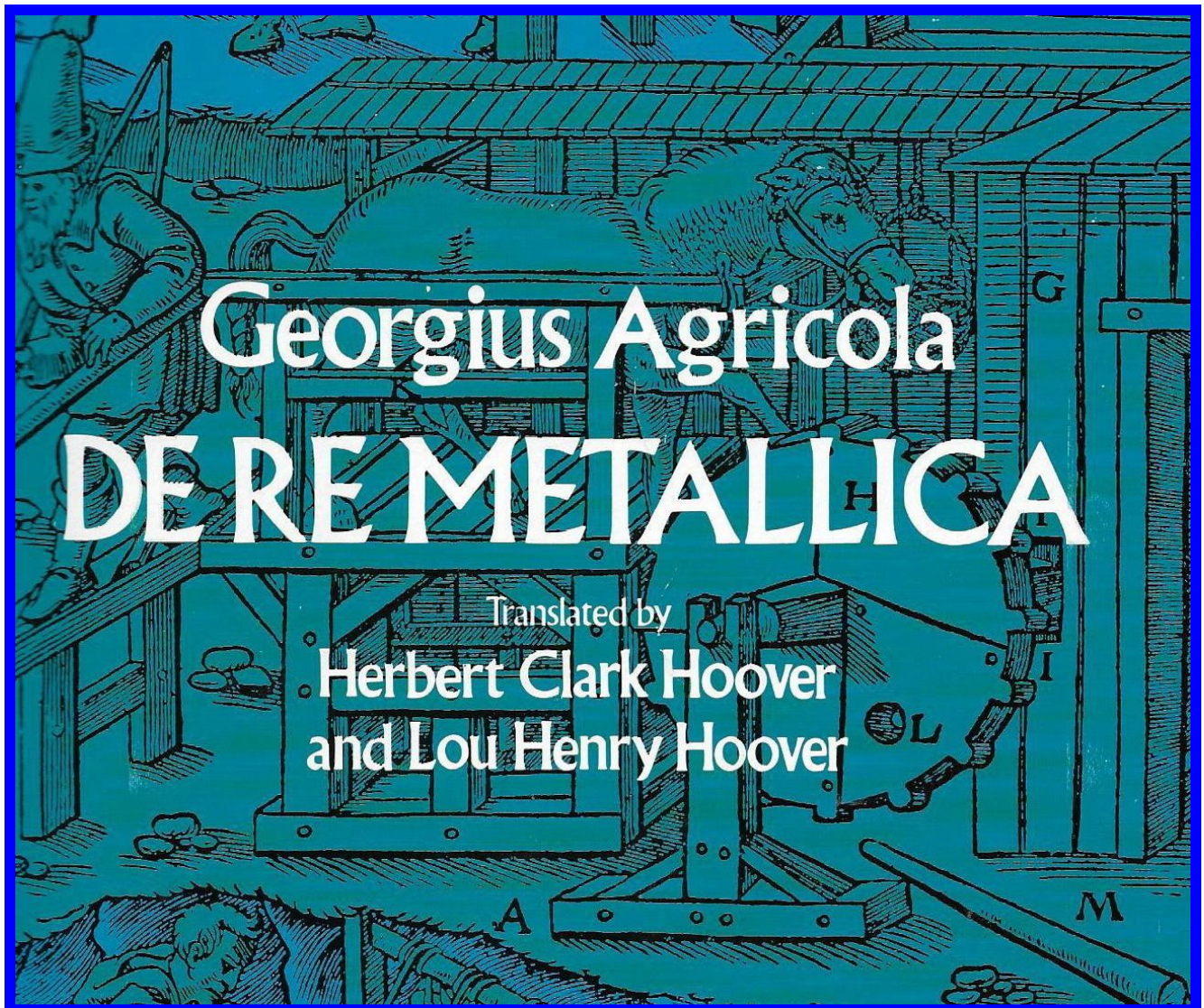


EARLY FANS FROM GERMANY
Extracts from De Re Metallica 1556

**Hand and Wind
Powered Fans**



I will now speak of ventilating machines. If a shaft is very deep and no tunnel reaches to it, or no drift from another shaft connects with it, or when a tunnel is of great length and no shaft reaches to it, then the air does not replenish itself. In such a case it weighs heavily on the miners, causing them to breathe with difficulty, and sometimes they are even suffocated, and burning lamps are also extinguished. There is, therefore, a necessity for machines which the Greeks call *πνευματικά* and the Latins *spiritalis*—though they do not give forth any sound—which enable the miners to breathe easily and carry on their work.

These devices are of three genera. The first receives and diverts into the shaft the blowing of the wind, and this genus is divided into three species, of which the first is as follows. Over the shaft—to which no tunnel connects—are placed three sills a little longer than the shaft, the first over the front, the second over the middle, and the third over the back of the shaft. Their ends have openings, through which pegs, sharpened at the bottom, are driven deeply into the ground so as to hold them immovable, in the same way that the sills of the windlass are fixed. Each of these sills is mortised into each of three cross-beams, of which one is at the right side of the shaft, the second at the left, and the third in the middle. To the second sill and the second cross-beam—each of which is placed over the middle of the shaft—planks are fixed which are joined in such a manner that the one which precedes always fits into the groove of the one which follows. In this way four angles and the same number of intervening hollows are created, which collect the winds that blow from all directions. The planks are roofed above with a cover made in a circular shape, and are open below, in order that the wind may not be diverted upward and escape, but may be carried downward; and thereby the winds of necessity blow into the shafts through these four openings. However, there is no need to roof this kind of machine in those localities in which it can be so placed that the wind can blow down through its topmost part.



A—SILLS. B—POINTED STAKES. C—CROSS-BEAMS. D—UPRIGHT PLANKS.
E—HOLLOWES. F—WINDS. G—COVERING DISC. H—SHAFTS. I—MACHINE
WITHOUT A COVERING.

The second machine of this genus turns the blowing wind into a shaft through a long box-shaped conduit, which is made of as many lengths of planks, joined together, as the depth of the shaft requires ; the joints are smeared with fat, glutinous clay moistened with water. The mouth of this conduit either projects out of the shaft to a height of three or four feet, or it does not project ; if it projects, it is shaped like a rectangular funnel, broader and wider at the top than the conduit itself, that it may the more easily gather the wind ; if it does not project, it is not broader than the conduit, but planks are fixed to it away from the direction in which the wind is blowing, which catch the wind and force it into the conduit.

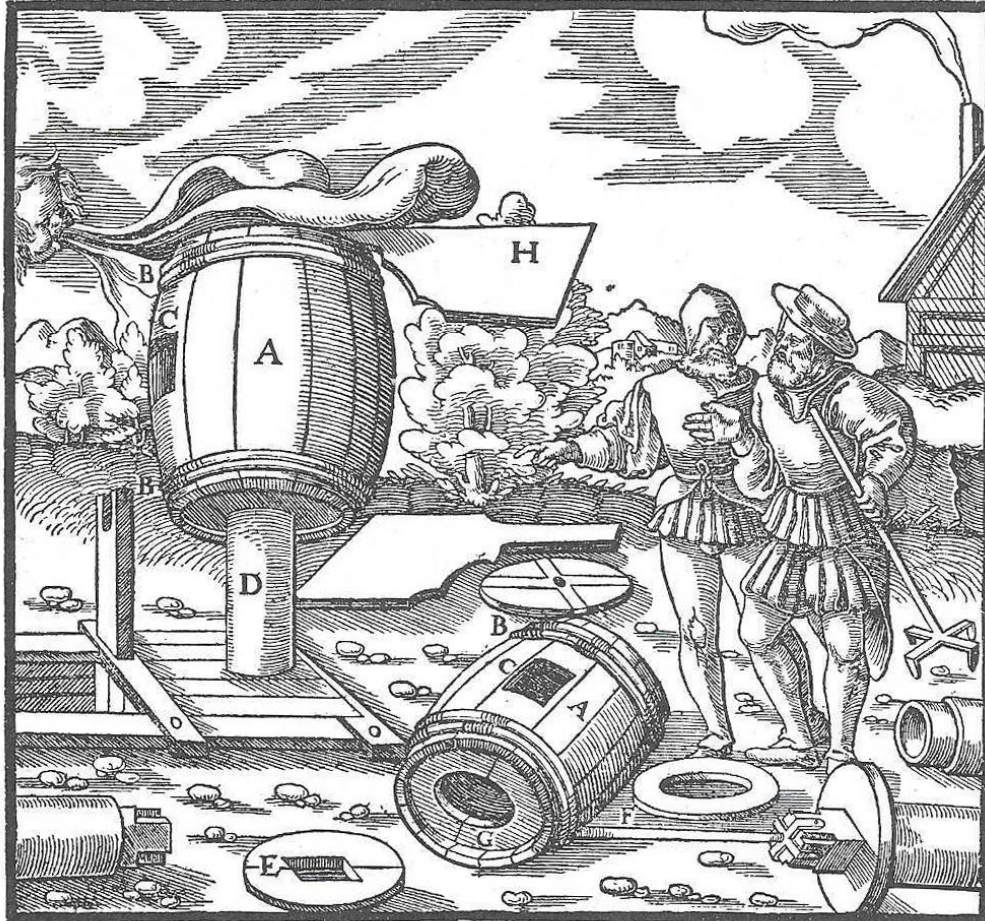
The third of this genus of machine is made of a pipe or pipes and a barrel. Above the uppermost pipe there is erected a wooden barrel, four



A—PROJECTING MOUTH OF CONDUIT. B—PLANKS FIXED TO THE MOUTH OF THE CONDUIT WHICH DOES NOT PROJECT.

feet high and three feet in diameter, bound with wooden hoops ; it has a square blow-hole always open, which catches the breezes and guides them down either by a pipe into a conduit or by many pipes into the shaft. To the top of the upper pipe is attached a circular table as thick as the bottom of the barrel, but of a little less diameter, so that the barrel may be turned around on it ; the pipe projects out of the table and is fixed in a round opening in the centre of the bottom of the barrel. To the end of the pipe a perpendicular axle is fixed which runs through the centre of the barrel into a hole in the cover, in which it is fastened, in the same way as at the bottom. Around this fixed axle and the table on the pipe, the movable barrel is easily turned by a zephyr, or much more by a wind, which govern the wing on it. This wing is made of thin boards and fixed to the upper part of the barrel on the side furthest away from the blow-hole ; this, as I have said, is square and always open. The wind, from whatever quarter of

the world it blows, drives the wing straight toward the opposite direction, in which way the barrel turns the blow-hole towards the wind itself; the blow-hole receives the wind, and it is guided down into the shaft by means of the conduit or pipes.



A—WOODEN BARRELS. B—HOOPS. C—BLOW-HOLES. D—PIPE.
 E—TABLE. F—AXLE. G—OPENING IN THE BOTTOM OF THE BARREL.
 H—WING.

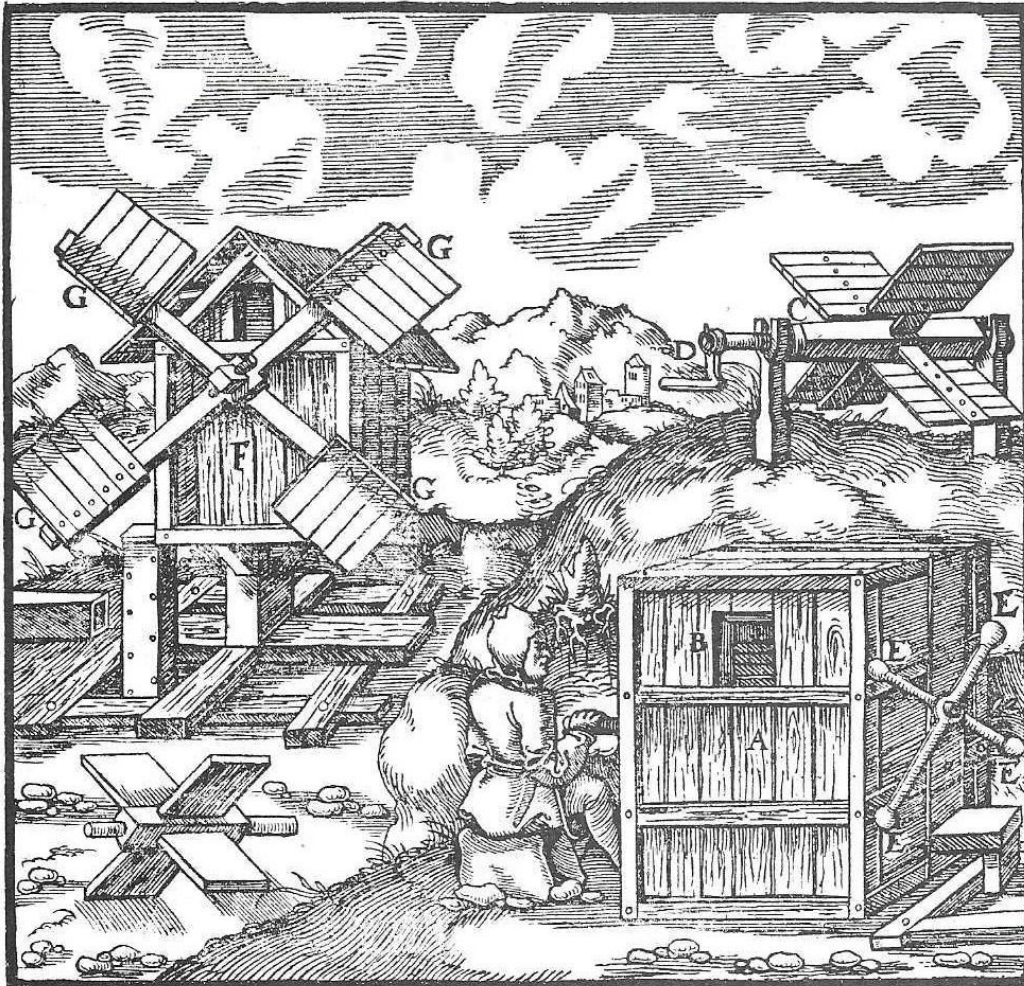
The second genus of blowing machine is made with fans, and is likewise varied and of many forms, for the fans are either fitted to a windlass barrel or to an axle. If to an axle, they are either contained in a hollow drum, which is made of two wheels and a number of boards joining them together, or else in a box-shaped casing. The drum is stationary and closed on the sides, except for round holes of such size that the axle may turn in them; it has two square blow-holes, of which the upper one receives the air, while the lower one empties into the conduit through which the air is led down the shaft. The ends of the axle, which project on each side of the drum, are supported by forked posts or hollowed beams plated with thick iron; one end of the axle has a crank, while in the other end are fixed four rods with thick heavy ends, so that they weight the axle, and when turned, make it



A—DRUM. B—BOX-SHAPED CASING. C—BLOW-HOLE. D—SECOND HOLE.
E—CONDUIT. F—AXLE. G—LEVER OF AXLE. H—RODS.

prone to motion as it revolves. And so, when the workman turns the axle by the crank, the fans, the description of which I will give a little later, draw in the air by the blow-hole, and force it through the other blow-hole which leads to the conduit, and through this conduit the air penetrates into the shaft.

The one with the box-shaped casing is furnished with just the same things as the drum, but the drum is far superior to the box; for the fans so fill the drum that they almost touch it on every side, and drive into the conduit all the air that has been accumulated; but they cannot thus fill the box-shaped casing, on account of its angles, into which the air partly retreats; therefore it cannot be as useful as the drum. The kind with a box-shaped casing is not only placed on the ground, but is also set up on timbers like a windmill, and its axle, in place of a crank, has four sails outside, like the sails of a windmill. When these are struck by the wind they turn the axle, and in this way its fans—which are placed within the casing—drive



A—BOX-SHAPED CASING PLACED ON THE GROUND. B—ITS BLOW-HOLE. C—ITS AXLE WITH FANS. D—CRANK OF THE AXLE. E—RODS OF SAME. F—CASING SET ON TIMBERS. G—SAILS WHICH THE AXLE HAS OUTSIDE THE CASING.

the air through the blow-hole and the conduit into the shaft. Although this machine has no need of men whom it is necessary to pay to work the crank, still when the sky is devoid of wind, as it often is, the machine does not turn, and it is therefore less suitable than the others for ventilating a shaft.

In the kind where the fans are fixed to an axle, there is generally a hollow stationary drum at one end of the axle, and on the other end is fixed a drum made of rundles. This rundle drum is turned by the toothed wheel of a lower axle, which is itself turned by a wheel whose buckets receive the impetus of water. If the locality supplies an abundance of water this machine is most useful, because to turn the crank does not need men who require pay, and because it forces air without cessation through the conduit into the shaft.



A—HOLLOW DRUM. B—ITS BLOW-HOLE. C—AXLE WITH FANS. D—DRUM WHICH IS MADE OF RUNDLES. E—LOWER AXLE. F—ITS TOOTHED WHEEL. G—WATER WHEEL.

Of the fans which are fixed on to an axle contained in a drum or box, there are three sorts. The first sort is made of thin boards of such length and width as the height and width of the drum or box require ; the second

sort is made of boards of the same width, but shorter, to which are bound long thin blades of poplar or some other flexible wood ; the third sort has boards like the last, to which are bound double and triple rows of goose feathers. This last is less used than the second, which in turn is less used than the first. The boards of the fan are mortised into the quadrangular parts of the barrel axle.



A—FIRST KIND OF FAN. B—SECOND KIND OF FAN. C—THIRD KIND OF FAN. D—QUADRANGULAR PART OF AXLE. E—ROUND PART OF SAME. F—CRANK.