C. Burleigh.

Steam & Air-Engine.

No. 93051. Patented Jul. 27. 1869.

Fig. 2.

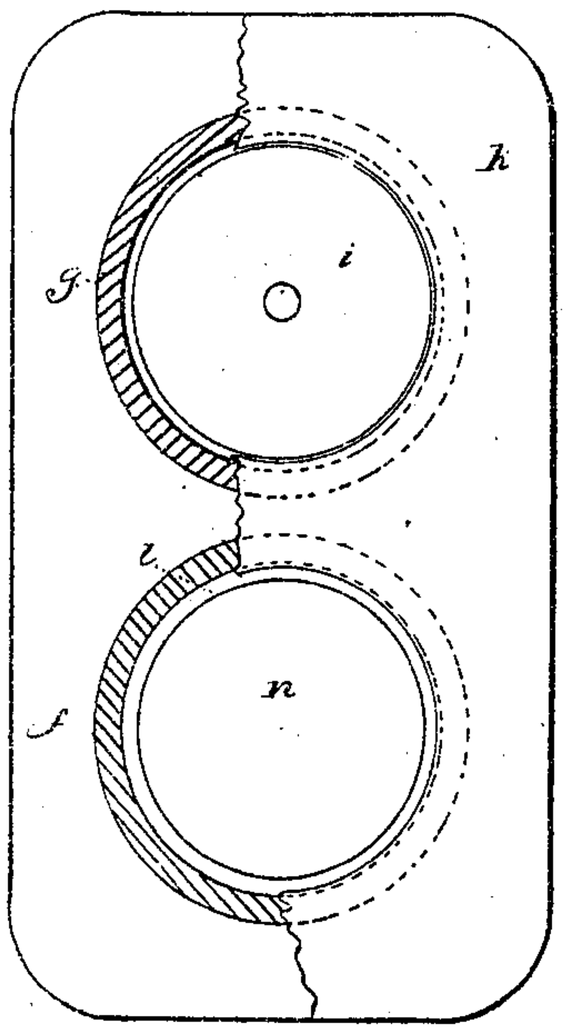

Fig. 1.

Witnesses:
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CHARLES BURLEIGH, OF FITCHBURG, MASSACHUSETTS.

Letters Patent No. 93,051, *dated July* 27, 1869.

IMPROVED STEAM AND AIR-ENGINE.

The Schedule referred to in these Letters Patent and making part of the same.

To all whom it may concern:

Be it known that I, CHARLES BURLEIGH, of Fitchburg, in the county of Worcester, and State of Massachusetts, have invented Improvements in Combined Steam and Air-Engines; and I do hereby declare that the following, taken in connection with the drawings, which accompany and form part of this specification, is a description of my invention sufficient to enable those skilled in the art to practise it.

In compressing air into a reservoir from which it is supplied to operate rock-drills and other engines, in shafts, tunnels, deep-cuttings, and elsewhere, in situations where the use of steam would involve waste of fuel and inconvenience consequent upon condensation of the steam, and where exhaust-steam would be inconvenient and often insupportable to the workmen employed, much difficulty has been experienced in operating air-pumps, because of the varying resistance offered to the air-condensing pumps, which resistance begins at nothing at the commencement of each stroke of the pumps and terminates at the full pressure existing in the air-reservoir.

One part of my invention consists in a peculiar arrangement of the crank of a steam-engine with reference to the cranks of two air-pumps, by which, when the engine-crank is moving past its dead-centres, and at its slowest rate of speed, the air-pump pistons are commencing their working strokes, and are performing the least amount of work required of them in the act of compressing air, and when the engine-crank is moving most rapidly at about half of the distance between its dead-centres, and when the steam on the steam-engine piston operates most effectively in rotating the engine-crank, the air-pump cranks move with decreasing velocity, and so as to bring their radii into line with the air-pump connecting-rods, so that said cranks and rods form, in effect, toggle-joints, which, in straightening, exert a most powerful effect at the time when the resistance to the movement of the air-pump pistons is greatest.

In compressing air, the latent heat therein is rendered sensible, and heats the working-parts of the pumps, which causes, by unequal expansion of the heated parts, unnecessary friction, leakage of valves, and other troubles and annoyances.

It has been common to surround such pumps with a jacket, and to cause cold water to flow through the jacket and around the heated parts, abstracting from said parts some of the caloric.

Another part of my invention relates to an improved method of applying water to absorb and carry off the heat generated or rendered sensible by the action of the pumps in compressing the air, said method consisting in the introduction of water into the pump-cylinders, so that it not only keeps the parts of the pumps from becoming heated, but also performs the office of a lubricant, checks and diminishes air-leaks, by occupying and itself leaking through spaces, through which air would otherwise pass, and prevents the eduction-valve from slamming upon its seat, by allowing it to settle no faster than the movement of the pump-piston in its receding stroke.

The drawing shows, in—

Figure 1, a vertical sectional elevation of an air-compressing engine, embodying the improvements comprised in my present invention.

Figure 2 showing, partly in plan, the common top-piece or chest, into which both pumps discharge air, the covers of the chest being removed, showing one eduction-valve, the other eduction-valve being removed for the purpose of exhibiting the induction-valve, which is seated on the air-pump piston.

The pumps shown are single-acting, and are arranged vertically, so that the valves connected therewith operate, in closing, by gravity alone, unaided by springs, both pumps acting to compress air by the upward strokes of their pistons, which pistons are made long, and are open at their lower ends, so that the air-pump connecting-rods enter the pistons and take hold of wrist-pins located as nearly as may be to the induction-valve seats, this arrangement obviating any necessity of the employment of cross-heads and ways or slides.

The steam-engine and air-pumps have one shaft in common, which is cranked for the pumps, the pump-crank wrists being in the same plane, one hundred and eighty degrees apart from each other, the steam-engine crank-wrist being secured in a fly-wheel on one end of the shaft and about forty-five degrees in advance or lead in the direction of rotation from one of the pump-crank wrists, and about two hundred and twenty-five degrees in advance of the other pump-crank wrist in the same direction.

The steam-engine cylinder may be located as is most convenient, either horizontally, as shown, or it may be placed vertically or inclined, the only matter of importance, as bearing on this invention in respect to the steam-engine, being that its crank-pin or wrist shall have substantially the specified relation to the crank-pins or wrists of the air-pumps.

In the drawings—

a is the bed-plate, having therein the bearings for the cranked shaft *b*, common to the pumps and the steam-engine, the crank-wrists for the pumps being denoted by *c* and *d*, and the steam-engine crank-wrist or pin by *e*.

The pump-cylinders *f* and *g* are supported on a suitable frame-work, directly over the crank-shaft, and are open at their lower ends, being bored of uniform diameter throughout their length.

On the top flanges of the pump-cylinders a plate, *h*, is fitted, in which two circular openings are made

concentric with the pump-cylinders, said plate serving as the seat for each of the eduction-valves *i*, which are of the poppet variety, and are guided in their vertical movements by stems fitting in sleeves made in the covers *j*, which close the openings formed in the air-chest *k*, which covers the plate *h*, and is common to both pump-cylinders, and connects and strengthens the top of the machine.

The air-pump pistons *l* are made as long hollow cylinders, open at both ends, the upper end of each having a flange, which projects slightly inward, a spider being cast in the upper end of each piston, which serves to receive a wrist-pin, *m*, and the guide and check-spindle of the inlet-valve *n*, which is of the poppet variety, and has its seat on the inwardly-projecting flange before mentioned.

The wrist-pins *m* are connected to the crank-pins *c* and *d*, by connecting-rods *o*, so that as shaft *b* is rotated in the direction indicated by the arrows seen in fig. 1, the air-pump pistons *l* are reciprocated in an obvious manner, the valves *n* lifting as the pistons descend, admitting air past the spiders in the pistons, and past the openings in the pistons controlled by the valves *n*, into the air-pump cylinders *f* and *g*, and when the pistons *l* rise in the air-pump cylinders, the valves *n* having closed by their own weight, the air above said valves is compressed until its elastic force is sufficient to overcome the weight of valve *i*, and the pressure of the air stored in the receiver beyond.

The opening of valve *i* occurs, sooner or later, before the pistons *l* arrive at the highest points in their stroke, according to the weight of valve *i* and the pressure existing in the chest *k*, and the reservoir beyond.

The chest *k* communicates with any suitable air-tank or receiver, by means of a pipe, *p*.

The pipe *q* serves to convey water to each pump, said pipe being branched to deliver between the valves *n* and *i*, so that the water will rest on the tops of the pistons *n*, in their ascent, and will lubricate the entire surfaces of the pump-cylinders, and will check the air from escaping through small leaks when the piston-packings are imperfect; the water also fills any clearances which exist between the valves *i* and *n*, and affords a body on which the valves *i* rest, and by which they are gently lowered upon their seats, as they descend, when the pistons *l* move downward.

The water also takes up the heat given out by the air as it is condensed and as it is generated by the force employed, and any excess of water and the vapors arising therefrom, are forced with the condensed air beyond valves *i*, into the receiver or tank, where the water settles to the bottom and is drawn off by means of a valve operated by a float in a well-known manner.

The water may be supplied from a sufficient head to enter the pumps at times when little or no pressure is present, a suitable check-valve being arranged in pipe *q* to prevent escape of air and backward flow of the water, or it may be supplied in jets from a pump properly timed and of the right capacity to deliver only the requisite quantity.

No harm results from allowing the water to drip from the open ends of the pump-cylinders upon the cranks beneath.

I claim the arrangement of cranks which make entire rotations, substantially as herein specified, in the combination of a steam-engine with single-acting air-compressing pumps.

Also, devices for introduction of water into vertical air-compressing pumps, arranged to deliver the water between the tops of the pump-pistons and the pump-delivery valves, substantially as herein specified.

CHARLES BURLEIGH.

Witnesses:
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