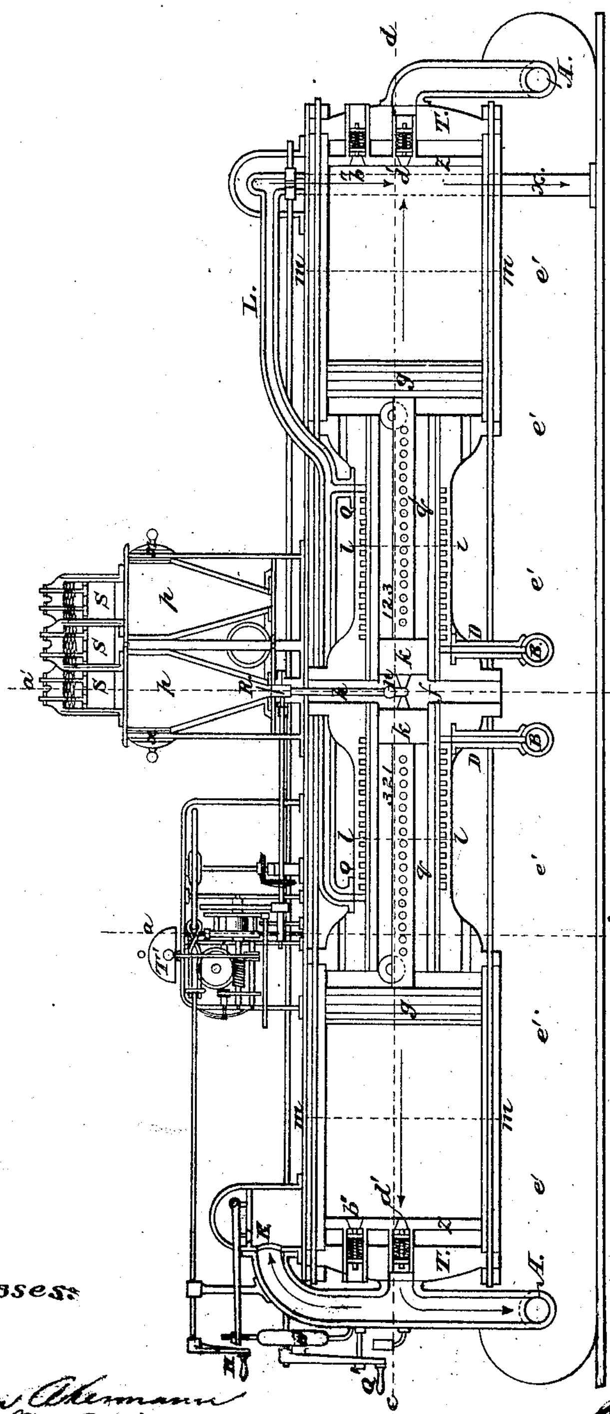
3 Sheets--Sheet 1.

C. CAROBBI & G. BELLINI.

Atmospheric Air-Compressor for Working Engines.

No. 159,075. Patented Jan. 26, 1875.



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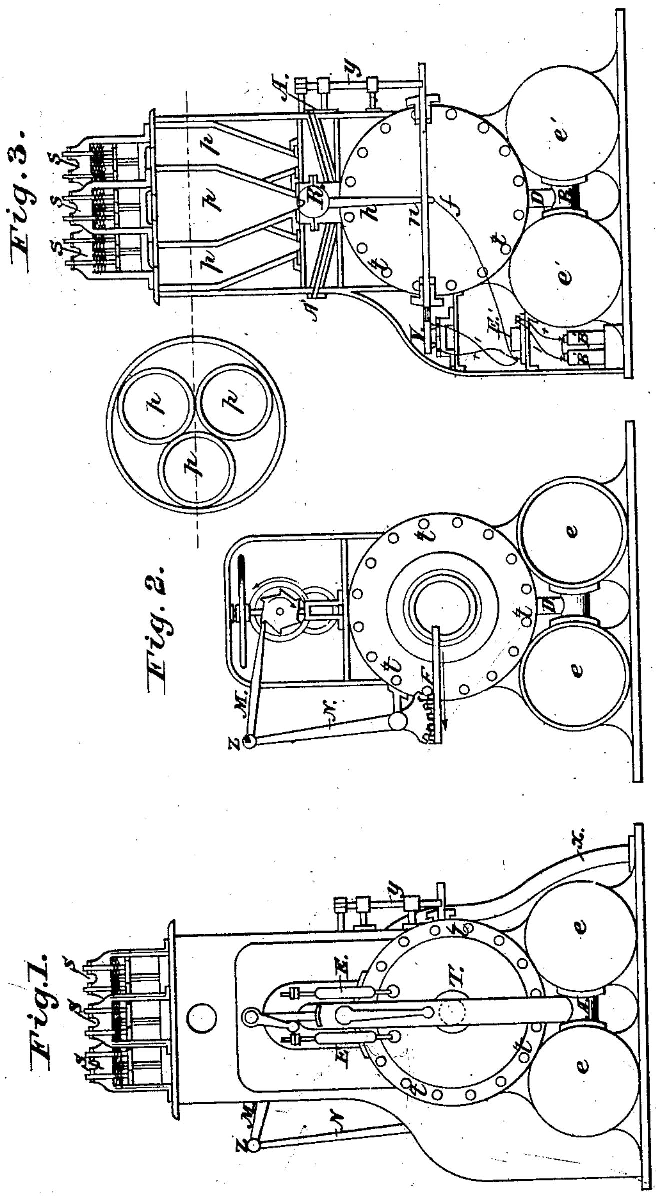

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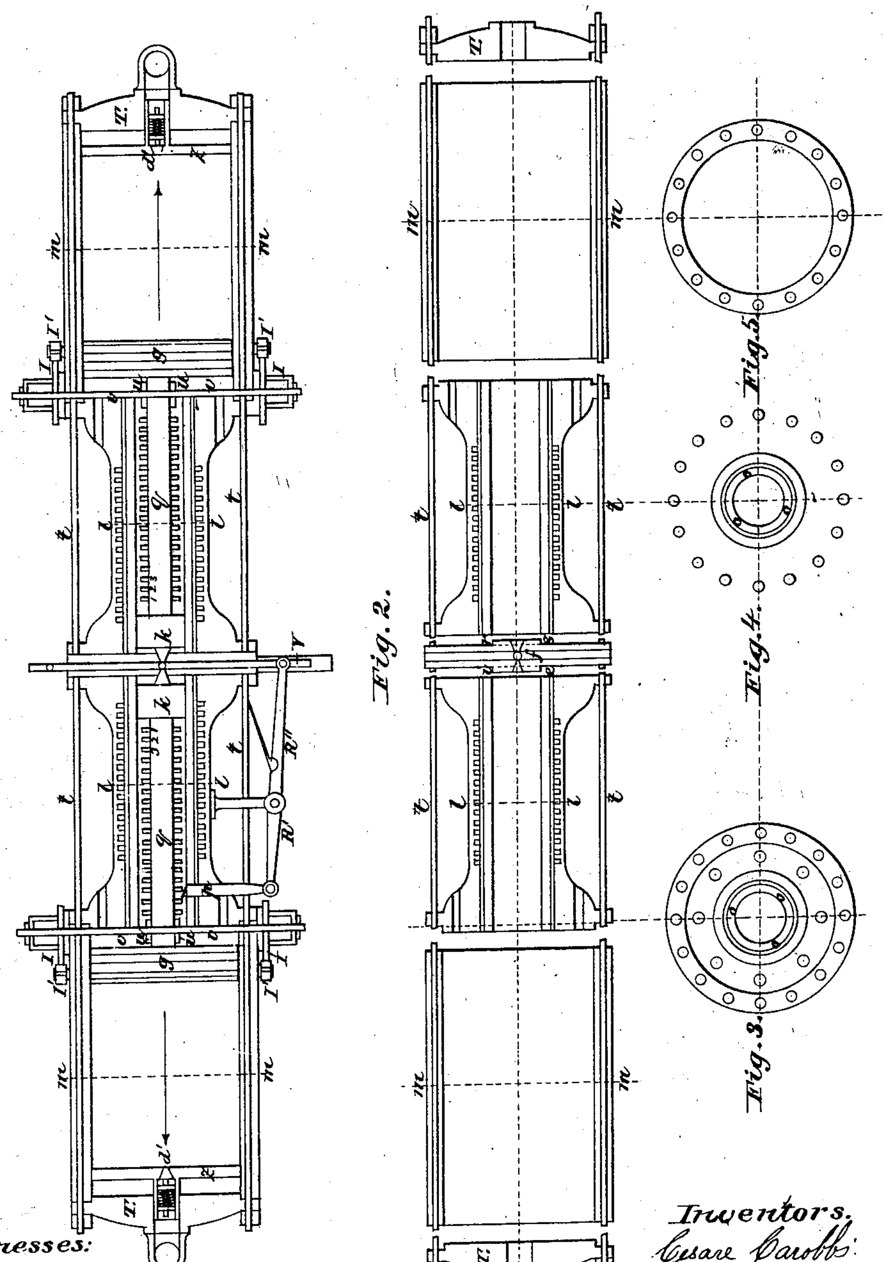

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UNITED STATES PATENT OFFICE.

CESARE CAROBBI AND GIUSEPPE BELLINI, OF PISTOJA, ASSIGNORS OF ONE-THIRD THEIR RIGHT TO JOHN REYNOLDS, OF PRATO, ITALY.

IMPROVEMENT IN ATMOSPHERIC-AIR COMPRESSORS FOR WORKING ENGINES.

Specification forming part of Letters Patent No. 159,075, dated January 26, 1875; application filed May 28, 1874.

To all whom it may concern:

Be it known that we, CESARE CAROBBI and GIUSEPPE BELLINI, both subjects of the King of Italy, and residing at Pistoja, Tuscany, in the Kingdom of Italy, have invented a Process and Machine for Working Locomotive and other motive-power Engines by means of atmospheric air, compressed by the combustion of fulminating matters, in substitution of steam, of which the following is a specification:

Carded cotton, hemp or linen tow, shreds of torn rags of the above materials, blotting-paper, and other similar substances, treated with a mixture of concentrated azotic and sulphuric acid when ignited develop an extraordinary explosive force without producing smoke or leaving any residue, or dirtying or deteriorating the vessel in which they have been burned. This explosive force we apply to setting in motion an apparatus, to which we have given the name of "the atmospheric-air compressor," by making small balls, which we call charges, of any of the above-named fulminating substances, and causing them to fall and then explode by means of an electric spark between the pistons of two sets of cylinders placed in juxtaposition on a right line, and which pistons, driven by the explosions in two opposite directions, force and compress the air contained in the cylinders into air-tight tanks. The air so compressed is conducted from these tanks to the propelling mechanism usual in steam-engines, and in its passage absorbing the heat that has been developed by combustion, its elastic potency will be increased, and in this state will act with all its expansive power, and in the same way as steam acts. Thus this compressor and the air-tight tanks take the place of the boiler and furnace in the usual construction of steam-engines, and can be applied to any engine where motive power is required.

We now refer to the three accompanying drawings to explain the construction and action of our invention.

Drawing No. 1 is a longitudinal section, in elevation, of the apparatus, obtained by the intersection of a vertical plane across its middle; Figure 1, Drawing No. 2, a front view of the compressor; Figs. 2 and 3, transversal sections of the same, respectively, taken in the points corresponding to the lines $a\ b^2\ a'\ b^1$ of Drawing No. 1; Fig. 1, Drawing No. 3, a horizontal section of the compressor, taken upon the line $c\ d$ of Drawing No. 1; Figs. 3, 4, and 5, sundry transverse sections, and Fig. 2 the principal pieces together, of which the compressor is composed.

f is a piece of cast-iron, so formed that a section of it, being made as indicated by the dotted lines *i e r s*, Fig. 2, Drawing 3, shows that it is composed of three concentric cylindrical portions, the largest of which is between the other two. This piece *f* has two perforations, one of which, *n*, Drawing 1, is transverse and horizontal, and the other, *h*, perpendicular to *n*, which, commencing at the upper circumference of *f*, terminates at its center, where there are two other small conical perforations opposite to each other on a right line crossing the bed of the perforation *h*. *l l* are two hollow cylinders, each formed of a steel core, *o*, Figs. 3 and 4, Drawing 3, around which is a band of copper, surmounted by a bronze cylinder, having in its inner side a spiral groove or female screw, and these three layers united together at both extremities by a circular ring form but one piece. These two cylinders (the one to the right, the other to the left) are attached to *f* by means of the short cylindrical projections of this piece, being made to enter into them, and causing a ring of each cylinder to come in contact with the remainder of the piece *f*, Fig. 2, Drawing 3. By the other ring, at the farther extremity of the cylinders *l l*, they are each joined to another cast-iron cylinder of larger diameter, *m m*, and these latter are closed at their other ends by means of the covers T. These four cylinders are thus placed on the same horizontal right line, and together with the piece *f* form a connected symmetrical whole, solidly held together by sixteen very robust steel ties, *t*, Drawing 3. The cylinders *l l* have each a metallic piston, *k*, terminating at the end toward *f* in a small cone, which serves to fill the conical holes *n* in that piece. At the other end, and forming one piece with the piston, there is to each attached a rectangular bar, q, which serves to join them to pistons g of the cylinders m m, Drawing 1. Inside cylinders m m, and near the covers T, there is in each a metallic disk, Z, that can slide in them, to which are fixed two small cylinders that slide in T, each containing an automatic valve, d' d''. d'' opens from outside to the inside of cylinders m m, and communicates with the atmosphere. d' opens in a like manner, and the tube in which it is contained slides in another tube fixed to the cover T, and which serves to make the cylinders m m communicate with the compressed-air tanks e' e', Drawings 1 and 2. These tanks are two hollow cylinders, of wrought-iron or steel, very strong, communicating with each other by means of the small horizontal tubes A A B B, and furnished with safety-valves E E. The said tanks receive the compressed air from cylinders m m. They are placed parallel to each other under the compressor in its longitudinal direction, which rests upon them.

The bars q that unite the pistons K and g, have transversely inserted in them sundry small steel cylinders, 1, 2, 3, &c., Fig. 1, Drawings 1 and 3, which, acting like teeth, move the small wheels u, and these the rods V, in which they are fixed. At each extremity of these rods there is a drum, similar in form to the drum of a watch, which is held firmly by the catch I', connected with a small crick-wheel, I, which can turn at pleasure, and so tighten a spiral spring inclosed in the said drum, one end of which spring is fixed to the rod V, the other to the drum. When the pistons K, driven from the piece f by the explosion of the fulminating-charge, arrive at the end of their stroke, and their force spent, this spring serves to push them back to their starting-point. At the aperture x, Drawing 1, there are three conical tubes, p, fixed with their apex turned downward to a circular revolving plane, toothed at its periphery. These tubes, (each furnished with a large safety-valve, S,) are for receiving the fulminating-charges. A handle turned by the machinist causes the circular plane on which they are fixed to revolve, and brings them in communication successively with the periphery of a wheel, R, Fig. 3, Drawings 1 and 2, which wheel, turning, presents at each of its revolutions a hole that receives a charge and precipitates it into the perforation h, where it falls by its own weight into the center of the piece f.

A very simple clock-work arrangement, shown in the upper part of Drawing 1, at A, consisting of a drum, in which is confined a spring tending to expand or unroll, gives, by the interposition of a small toothed wheel, movement to the wheel R, for receiving the charges, regulated by a brake moved by the handle H, and placed on the periphery of a fly-wheel connected to the movement. The rod upon which the spring in the drum acts, being formed as a screw, gives movement to a wheel, the rod of which, being also a screw, moves another, which has fixed upon its axis an index, which shows the quantity of charges that become consumed, in order to regulate their repetition; but even should the machinist fail to give attention to this index, a small bell, T', struck by a hammer, gives the opportune signals.

As the spring which gives movement to this mechanism would soon lose its necessary tension, at every turn of the wheel R its force is restituted by means of the piece P, moved by the piston K and the levers M and N, pivoted in Z'. The said piston K moves also the cylindrical rod that traverses through the hole n of the piece f, pivoted to the balance-shaft R' R'', Fig. 1, Drawing 3.

To put the apparatus in motion, the conical tubes p are filled by hand with fulminating-charges, and the clock-work movement set free. The wheel R takes a charge from one of the tubes and lets it fall through the perforation h into the center of the piece f. In the other perforation, n, there is the cylindrical rod above that acts as a valve, and which a spring tends to impel in a contrary direction to the arrow, Fig. 1, Drawing 3, but is withheld by the vertical rod y, Figs. 1 and 3, Drawing 2, in order that the hole in its middle may coincide with the perforation h, and let the charge pass, but immediately this has taken place the clock-work movement lifts the rod y, and the cylindrical rod moves forward, intersecting the perforation h, and imprisoning the charge in the center of f, where, at the opportune moment, an electric spark ignites it. A large quantity of gas is developed, and its elastic force, acting upon the pistons K, drives them in opposite directions without the explosion causing the least jar to the apparatus, in consequence of the two contrary directions given to the pistons neutralizing the shock.

The pistons g, which are united to the pistons K, as soon as they move will close the valves b'', compress the air of the cylinders in which they work, and force the valves d' to open and admit the compressed air to pass into the tanks e' e', when, having arrived at the end of their stroke, and spent their propulsive force, will immediately recede again toward their starting-point, and, by their back-stroke, the gas that may have accumulated in cylinders l l from the explosion will be driven up the perforation h, and pass out into the atmosphere through the openings A' A', Fig. 3, Drawing 2. At the back of the disks Z there is an elastic packing to protect the covers T from concussion, in case the pistons g should not at the end of their stroke have spent their entire force. The compressed air is conducted from the tanks by the tubes D D, and, passing through the grooves of the cylinders l l, is there increased in tension by absorbing the heat that has been communicated to them by the combustion of the charges. This gives the double advantage of keeping the center of the piece f cool, which is necessary to avoid the spontaneous combustion of the charges, and at the same time increasing the motive power of the compressed air.

In the tubes D D there is a valve opening from underneath upward, which prevents the heated compressed air returning into the tanks, notwithstanding that the equilibrium between the air in them and that that has passed through the tubes has been destroyed, in consequence of the greater tension acquired by the latter from heating. From the grooves of the cylinders l l the compressed air passes, by the tubes Q Q, into a single tube, L, where the governor, moved by handle Q′, introduces it, by means of the tubes X, into the usual cylinders employed in steam-engines for communicating motion to the machinery, and becomes a force capable of being distributed to any operating mechanism.

It now remains to be shown how the fulminating-charges are ignited. In the longitudinal middle of the apparatus, as seen in Drawing 2, on the right-hand side of Fig. 3, there are two Daniel batteries of the Minotte type, B′, placed in a box resting on several spiral springs, and connected to a suspended table. These batteries put in activity a Ruhmkorff coil, E′. The positive and negative currents that pass from this coil communicate with two copper plates, insulated from each other by an ivory plate, and, in consequence, the positive current bifurcates and penetrates in the center of piece f, with which it is insulated. The valve that incloses the fulminating-charges in this point has in its prolongation V two projections, terminating in a spring. One of these communicates constantly with the negative copper plate. The other, where the valve is held back by the piece Y, is in contact with the ivory plate, and the electric circuit is open, and no effect is manifested in the center of f containing the charges, but immediately the above valve is left free from Y it moves, and the other projection communicates with the positive copper plate, the current becomes closed, and the electric spark shoots from the positive to the negative pole, and in its passage traverses and ignites the fulminating-charge.

Having now described the principles of our invention, we may add that the advantages we expect to be realized from it are many and important, especially in its application to locomotive and marine engines: First, in economy. The fulminating matter would cost much less than coal. For locomotives the tender, and waste of power for dragging it filled with water and coal, would be saved, and in sea-going vessels much less space than that occupied for bunkers, coal, &c., would be required. The coal, and time expended for getting up steam, would also be saved, as an engine, worked on our invention, would only consume when in action, and would always be ready to start, as the tanks e' e' might always be kept charged with compressed air; but should they not be so, it being easy to repeat the ignition of the charges with great rapidity, the pressure could be got up in a few minutes, and when in action the power and velocity can be regulated as required by slackening or increasing the rapidity of the discharges. Secondly, in the total absence of smoke, especially in tunnels, stations, confined localities, and aboard ships. Thirdly, obviating, in marine engines, the risk of running short of coal on the voyage, atmospheric air being always present.

We claim as our invention—

1. The combination, substantially as before set forth, of the charger for the explosive material, the piston for receiving the force of the explosion, and the air-compressing piston and cylinder for compressing air.

2. The combination, substantially as before set forth, of the charger, the piston for receiving the force of the explosion, the air-compressing piston and cylinder, and the electric apparatus for igniting the explosive material.

3. The combination, substantially as before set forth, of the charger, the piston for receiving the force of the explosion, the air-compressing piston and cylinder, the electric apparatus, and the compressed-air tank.

4. The combination, substantially as before set forth, of the charger, the piston for receiving the force of the explosion, the grooved cylinder thereof, and the air-compressing cylinder and piston.

5. The combination, substantially as before set forth, of the charger for the explosive material and the explosion-pistons, arranged to move in opposite directions.

6. The combination, substantially as before set forth, of the two explosion-pistons and their cylinders, and of the two air-compressing pistons and their cylinders, all in the same line.

7. The combination, substantially as before set forth, of the charger, the piston for receiving the force of the explosion, the air-compressing piston and cylinder, and the spring for effecting the return movement of the said two pistons.

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