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E. BOTHNER

ELECTROMAGNETIC COMPRESSOR

Filed Oct. 3, 1923

2 Sheets-Sheet 1

Fig. 1.

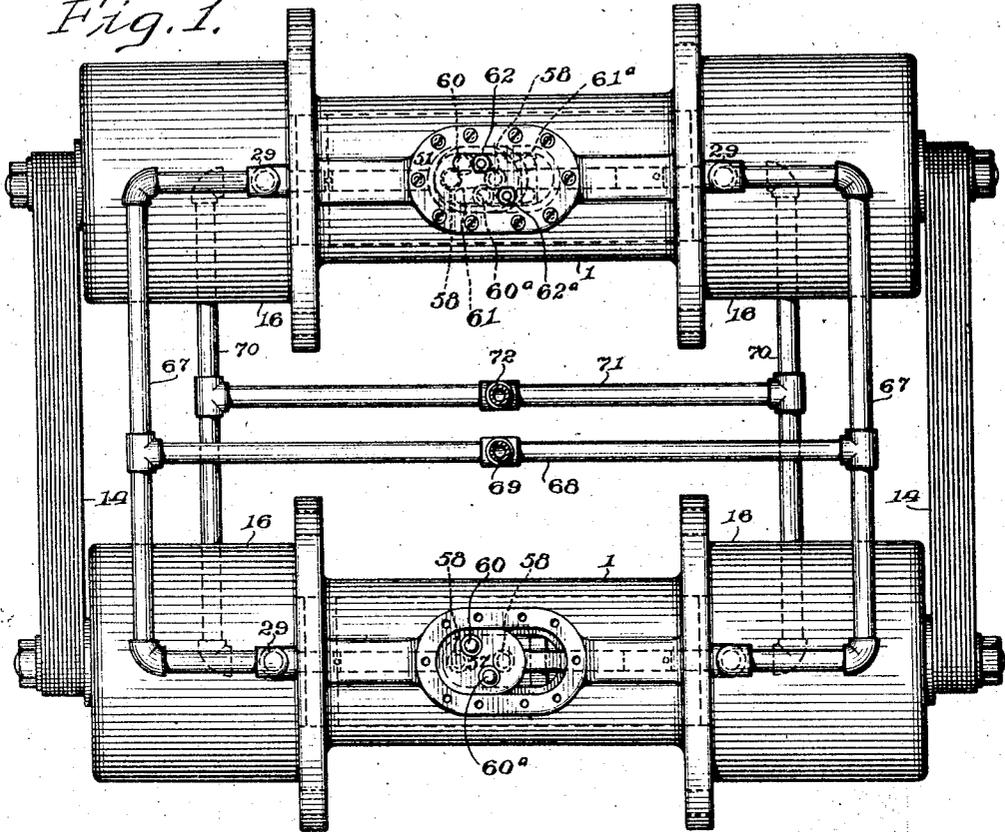
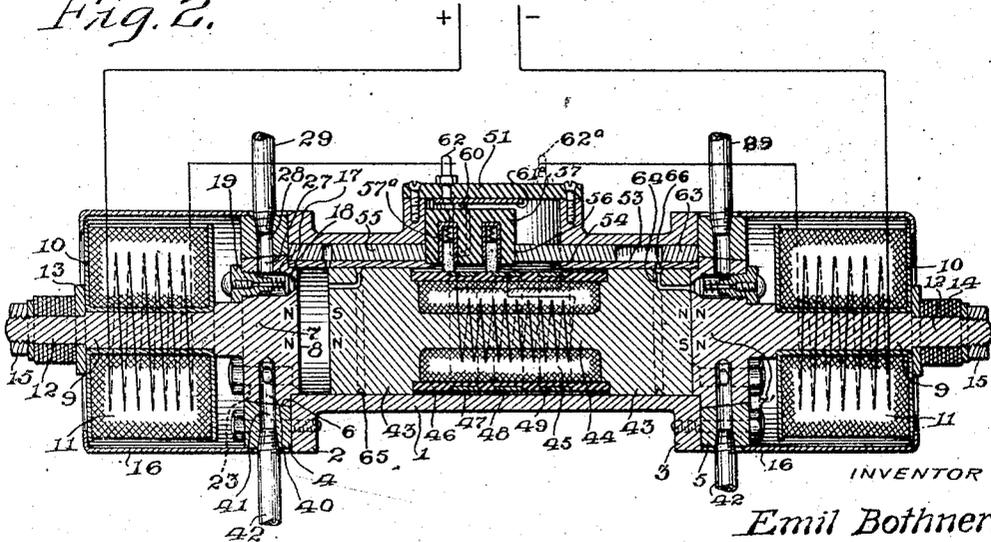


Fig. 2.



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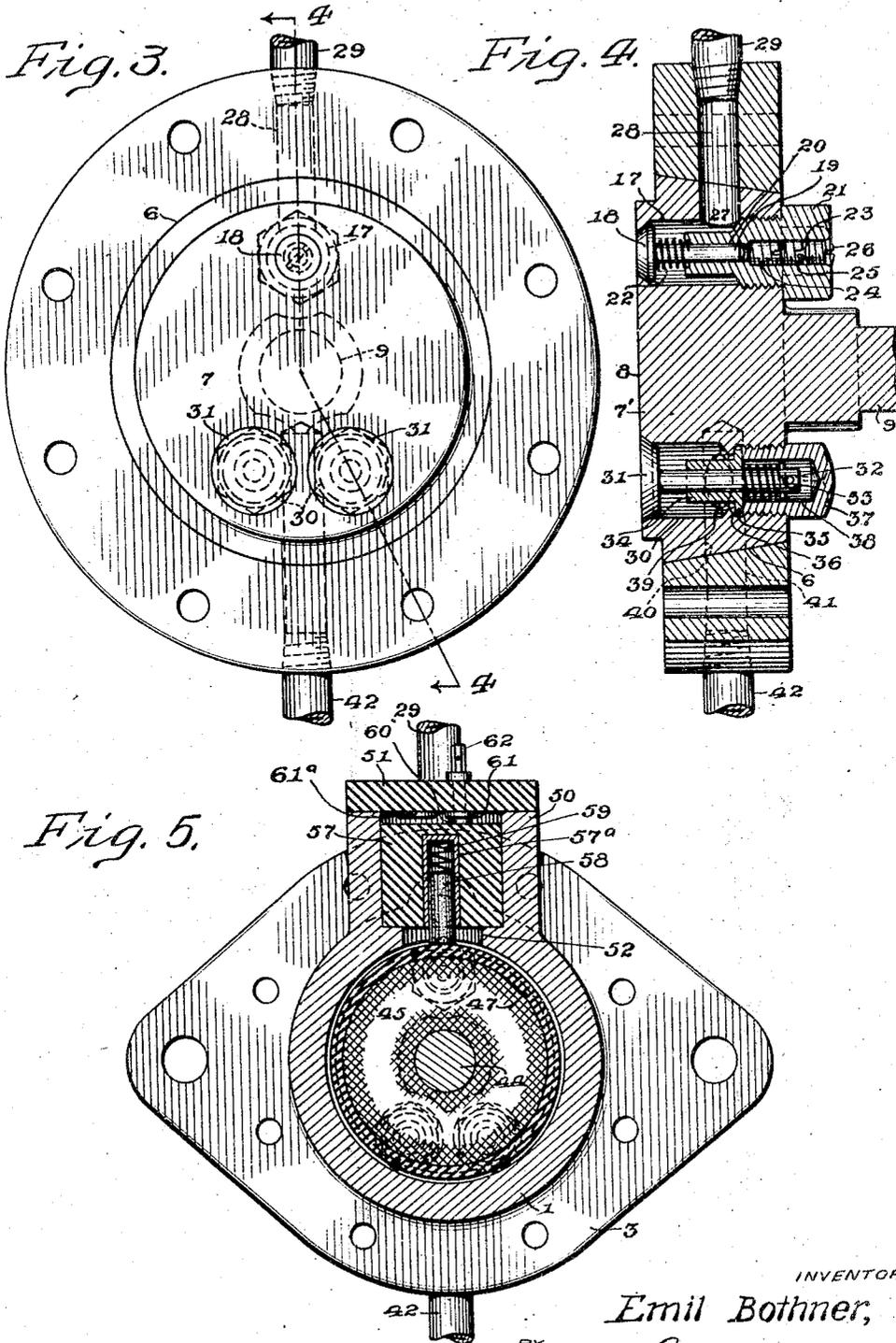
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2 Sheets-Sheet 2



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# UNITED STATES PATENT OFFICE.

EMIL BOTHNER, OF FLORAL PARK, NEW YORK.

ELECTROMAGNETIC COMPRESSOR.

Application filed October 3, 1923. Serial No. 666,227.

*To all whom it may concern:*

Be it known that I, EMIL BOTHNER, a citizen of the German Republic, residing at Floral Park, in the county of Nassau and State of New York, have invented certain new and useful Improvements in Electromagnetic Compressors, of which the following is a specification.

The object of this invention is to provide improvements in electro-pneumatic gas compressors, in the details of construction, and in the operation thereof.

Another object is to provide a reciprocatory piston, which at the same time comprises an electromagnet, the respectively opposite ends of which are operative to be alternately attracted and repelled with mutual respect to adjacent relatively fixed magnets.

A further object is to provide in such an apparatus a magnet, fixed with respect to the reciprocatory piston, and provided with inlet and outlet ports, the alternate opening of which is controlled by suitable spring-pressed valves.

Still another object is to provide, in combination with the reciprocatory piston, a commutator carried thereby, a member adapted to reciprocate in phase yet not in unison with said piston, a plurality of contacts movable with said member and with respect to said commutator, to permit an electric current to change the polarity of the piston ends with respect to relatively stationary magnets positioned adjacent thereto, whereby the current propels the piston first in one direction and then in the other.

And a still further object is to provide in such a construction a small bore within each end portion of the piston and leading towards the reciprocatory member, a stationary partition between the piston and the said member and having apertures with which the said bores alternately register, said apertures being positioned longitudinally beyond the limit of movement of the said member, whereby air compressed by the piston within the surrounding cylinder escapes through the bores alternately as they register with the respective apertures, and admit air pressure behind and operative to reciprocate the said member, which thereby carries the contacts into co-operation with such segments of the commutator as will effect a reversal of the magnetism of the piston, and its resulting movement.

With these and other objects in view, the

present invention comprises further novel details of construction hereinafter fully brought out in the following description when read in conjunction with the accompanying drawings, in which Fig. 1 is a top plan view of a pair of compressors coupled in tandem, so as to complete a magnetic circuit upon the exterior of each unit, and with the compressed air channels connected in parallel; Fig. 2 is a vertical, longitudinal section through one of the independent compressor units; Fig. 3 is a section on the line 3—3 of Fig. 2; Fig. 4 is a section on the line 4—4 of Fig. 3; and Fig. 5 is a section on the line 5—5 of Fig. 2.

Referring to Fig. 2 of the drawings, one embodiment of the invention comprises a cylindrical member 1, provided at its opposite ends with radially extending flanges 2 and 3, to the former of which is removably secured an annular ring 4, while to the latter is secured a similar ring 5, each of said rings having a centrally positioned aperture defined by a conical surface 6, within and closely fitted adjacent to which is a similarly shaped valve-plate 7 of a member having a reduced end portion 8 extending a relatively slight distance within the neighboring portion of the cylinder 1, and directly against the latter in such manner as to prevent transverse vibration of said plate within its own plane. Said plate is provided upon its outer surface with an integral axially extending reduced portion 9, surrounding which is a pole 10 supporting the helix 11 of an electromagnet, the core of which is the reduced portion 9 of the valve-plate 7, which forms one of the poles.

The portion 9 is further reduced at and surrounded by a washer 13, adjacent to which are formed the end portions of a preferably laminated yoke 14, operative to magnetically connect said electro-magnet with a second and similar magnet within a neighboring compressor unit, the laminations of said yoke being removably maintained in operative position by any suitable means such as a nut 15.

The oppositely positioned valve-plates, extensions, etc., are exactly similar, wherefore they have been similarly numbered, while each of the electro-magnets is preferably covered to prevent injury to the coils or an accumulation of foreign particles thereupon by means of a cylindrical closure 16. Each of the valve-plates 7 is provided with a

transversely extending bore or port 17, outlet of which is regulated by a valve 18 carried by a stem 19 extending slidably within an axially positioned bore 20 in a plug 21 removably secured within the bore 17, while a suitable coil-spring 22 surrounds said stem between the valve and the plug to maintain said valve in normally closed position against its seat. The bore 20 of the plug is enlarged at 23 to receive a set-screw 24 or the like, which, being within the path of the longitudinal movement of the valve-stem, regulates the movement of the latter and thereby the effective area of the inlet port. The position of the plug 24 being predetermined, it is set by means of a lock-screw 25, while the enlarged portion of said bore is adapted to be closed by a removably positioned plug 26, to prevent dust and dirt from entering said bore.

Exit from said outlet bore 17 is by way of a radially extending bore 28 within the ring 4, and into which leads a pipe 29. The said valve-plate 7 is furthermore pierced by one or preferably two transversely extending bores 30, each of which is adapted to be closed by means of a valve 31 carried by a stem 32, in turn encircled by a spring 33, and co-operating with a plug 34, having an annular flange 35 resting upon an annular shoulder 36 within the bore 30. Said plug is maintained removably in operative fixed position by means of a plug 30, hollowed at 38 to receive the free end portion of the valve-stem and surrounding coil-spring. Air or other gas passing from within the compressor through the exhaust ports or bores 30 pass through laterally disposed apertures 39 into a common radially extending bore 40, in alignment with which is a bore 41 within the ring 4, and into which last-named bore is secured a pipe 42.

Mounted to reciprocate within the cylinder 1, which latter by the way is of non-magnetic material, is a dumb-bell-shaped member of magnetic metal, comprising oppositely positioned heads 43 connected by a centrally reduced portion 44 comprising the core of an electro-magnet, which is surrounded by a wire helix 45, which in turn is surrounded by a cylindrical member 46 of insulating material, said last-named member being preferably provided with three annular grooves, in which are positioned similarly shaped circumferentially extending rings 47, 48 and 49.

As may be clearly seen in Fig. 2, one end of the helix 45 is connected to both of the outer rings 47 and 49, while the other end of said helix is connected with the central ring 48 only. The member 1 intermediate of its ends is provided with a radially extending integral housing 50, comprising parallel oppositely positioned side walls connected at their opposite end portions and adapted to be closed by means of a remova-

ble cover 51 of insulating material, said walls and cover inclosing a chamber connected with the bore of the member 1 by means of a radially extending longitudinally elongated passage-way 52.

Lying within the member 1 is a fixedly positioned partition 53, centrally apertured at 54, while between said partition and the adjacent wall of the surrounding member is a reciprocatory member 55, having a central aperture 56, in which is secured the inner portion of a block 57 of insulating material, into which is moulded cylindrical metallic housings 57<sup>a</sup>, in which are slidably mounted brushes 58, normally pressed outwardly by means of a spring 59 into engagement with the surface of the cylindrical member 46 and the annular metallic members 47, 48 and 49, which together comprise a commutator. Each of the housings 57<sup>a</sup> is electrically connected with a housing in which upwardly directed brushes 60 are positioned, these latter brushes slidably engaging metallic contact plates 61 and 61<sup>a</sup>, carried upon the undersurface of the cover 51, while connected with each of said plates and extending through said cover are binding-posts 62 and 62<sup>a</sup>.

The opposite end portions of the space between the partition 53 and the adjacent wall of the non-magnetic member 1 are filled by suitable blocks 63, adjacent to which the partition 53 is provided with restricted apertures 64. The reciprocatory member 43-44 is then provided with an angular bore extending inwardly from each of the outer faces of the head portions 43 inwardly and thence radially into a circumferential groove 65, which grooves are so positioned that one of them registers with one of the restricted bores 66 in the partition 53, when the reciprocatory member is in each of its extreme opposite positions of movement. It will also be noted that the oppositely directed aligned openings of the bore 64 may if desired be arranged in alignment with the other ports 17, and co-axial with the valves 18, though this is not an essential requirement to the satisfactory operation of the device.

Referring to Fig. 1, a pair of compressor units hereinbefore described in detail is connected up by means of the laminated yokes 14, while the other pipes 29 are connected together by means of a pipe 67 at each of the adjacent ends of the said units, while said last-named pipes are connected together to a pipe 68, from which a pipe 69 may conduct the compressed air or other gas towards or into any predetermined location, machinery, or refrigerating system, for which this improved unit is particularly adapted.

When employing this compressor for refrigeration purposes, the gases which may be compressed number among others ammonia, sulphur-dioxide, carbon-dioxide, pro-

pane, etc., where the compressor is employed merely to compress air to the pipes 42 directly from the atmosphere, but where the compressors comprise a part of the refrigerating system or the like, the pipes 42 are connected between adjacent ends of a pair of compressors by means of a pipe 70, said pipe 70 being connected by a pipe 71, which in turn is connected by way of a pipe 72 into the refrigerating circuit.

In the operation of this device, and referring particularly to Fig. 2, it is assumed that the windings of the respective solenoids or electro-magnets are connected to the respective plus (+) and minus (-) sides of a direct source of electric power. With the member 43 in the position illustrated, the electric current energizes the winding 11 and core 9 in such manner that the head 70 becomes positively magnetized, or, for sake of convenience, will be referred to as a north-pole. The current continuing on through the helix 45 magnetizes the head 43 of the reciprocatory member adjacent to the head 70 negatively, or as a south-pole, and the opposite head of said member positively, or as a north-pole. The current continuing on energizes the head 7' positively as a north-pole.

With this arrangement, the unlike poles and the like poles, as usual, repel, so that the reciprocatory member is thrust toward the left-hand side of the device (as in Fig. 2). The gas adjacent to the head surface 8 is compressed and expelled through the outlet port 17, past the valve 18, and through the pipes 29, 67 and 69. However, as the movement of the member 43 is substantially completed, a slight residual gas pressure passes through the adjacent angular bore 64 and creates a slight puff of gas through the peripheral groove 65, and outlet aperture 66 in the partition 53, thus creating a pressure to the left side of the member 55, which instantly forces said last-named member towards the right-hand side of the device.

The brushes 58 being carried with the member 55 out of contact with the commutator members 47 and 48, and into contact with the commutator members 48 and 49, the polarity of each of the end portions of the reciprocatory member 44 is changed respectively from south to north and from north to south, so that by reason of the stationary magnets' polarity remaining the same, the reciprocatory member is oscillated again into the position illustrated in Fig. 2, and substantially at the completion of its motion, the member 55 is impelled by air pressure as hereinbefore described into the left-hand position also shown in Fig. 2.

This cycle of operation continuing, the reciprocatory member maintains a continual oscillatory motion, which emits compressed gases, first through one and then the other

of the pipes 70, causing a substantially continuous flow of compressed gas through the pipes 71 and 72. As hereinbefore referred to, each of these compressor units may be employed singly, but if yoked together in tandem as shown in Fig. 1, the continuity of the flow of gases will be obviously more nearly even, the resulting pressure of the gas within the pipe 72 will be accordingly increased, and the magnetism of the oppositely directed free end portions of the stationary magnet-cores will be conserved through the laminated yokes 14, which by virtue of well-known magnetic laws will tend to increase the efficiency of the resulting compressor.

Having thus described my invention, what I claim and desire to protect by Letters Patent of the United States is:—

1. A pump, comprising a casing, a reciprocatory member having a portion formed of magnetic metal, a winding surrounding said metallic portion and adapted to be connected in an electric circuit, an electro-magnet adjacent to each of the opposite ends of said casing and also adapted to be connected in an electric circuit, a reciprocatory commutator operative whereby the magnetism of said member and one of the end magnets draws the former in one direction, and then whereby the magnetism of said member and the other end magnet draws said member in the opposite direction, and valves controlling the passage of fluid from said casing alternately to the opposite sides of said commutator, whereby residual fluid pressure when said first member approaches the end of a stroke reciprocates said commutator into its respective magnet-controlling positions.

2. A pump, comprising a casing, a reciprocatory piston having a portion formed of magnetic metal, a winding surrounding said metallic portion, commutator sections connected with the ends of said winding whereby the latter is connected in an electric circuit, an electro-magnet adjacent to each of the opposite ends of said casing and also adapted to be connected in an electric circuit, a sliding contact mechanism to automatically reverse the flow of an electric current through the piston winding and to thereby reverse the polarity of said piston, intake and exhaust valves operative to insure a unidirectional flow of fluid through said casing, and valves operative to permit a portion of the compressed fluid within said casing to pass alternately to the opposite sides of said mechanism to reciprocate the contacts thereof.

3. A pump, comprising a casing, a reciprocatory electro-metallic portion within said casing, a relatively stationary electro-magnet adjacent to each of the opposite ends of said casing, a winding surrounding said

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 piston, commutator sections carried by said piston and connected with said winding, a reciprocatory member within said casing, brush contacts carried by said member, and pneumatically actuated control valves for shifting the position of said member as said piston ceases movement in one direction, whereby a current passing through said contacts and sections reverses the polarity of said piston and operates to move said piston in the opposite direction. 45

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 4. A pump, comprising a casing, a reciprocatory electro-metallic portion within said casing, a relatively stationary electro-magnet adjacent to each of the opposite ends of said casing, a winding surrounding said piston, commutator sections carried by said piston and connected with said winding, a reciprocatory member within said casing, brush contacts carried by said member, intake and outlet valves at each end of said casing to insure a unidirectional flow of fluid through the casing, and a fluid passage-way at each end of said piston leading to spaces adjacent to said member, whereby as the motion of the piston ceases in one direction the residual pressure between the piston and the outlet valve is permitted to shift the position of said member so that a current passing through said contacts and sections reverses the polarity of said piston and operates to move said piston in the opposite direction. 50

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 25  
 30  
 35  
 40  
 5. A pump, comprising a casing, a reciprocatory electro-metallic portion within said casing, a relatively stationary electro-magnet adjacent to each of the opposite ends of said casing, a winding surrounding said piston, commutator sections carried by said piston and connected with said winding, a reciprocatory member within said casing, brush contacts carried by said member, intake and outlet valves at each end of said casing to insure a unidirectional flow of fluid through the casing, and a fluid passage-way at each end of said piston leading to spaces adjacent to said member, whereby as the motion of the piston ceases in one direction the residual pressure between the piston and the outlet valve is permitted to shift the position of said member so that a current passing through said contacts and sections reverses the polarity of said piston and operates to move said piston in the opposite direction. 55

60  
 65  
 70  
 75  
 6. A pump, comprising a pair of casings, an electro-magnet in each of the ends of each casing, electro-magnetic yokes connecting the corresponding magnets of said casings together, a reciprocatory piston in each casing, pneumatically actuated means to reverse the polarity of each of said pistons, intake and exhaust valves connected with each of the spaces between the respective pistons and the casing ends, conduits connecting the several intake valves together, and conduits connecting the several exhaust valves together, whereby the movement of said pistons supplement each other to provide a unidirectional flow of fluid in a trunk line conduit.

In testimony whereof I have affixed my signature.

EMIL BOTHNER.