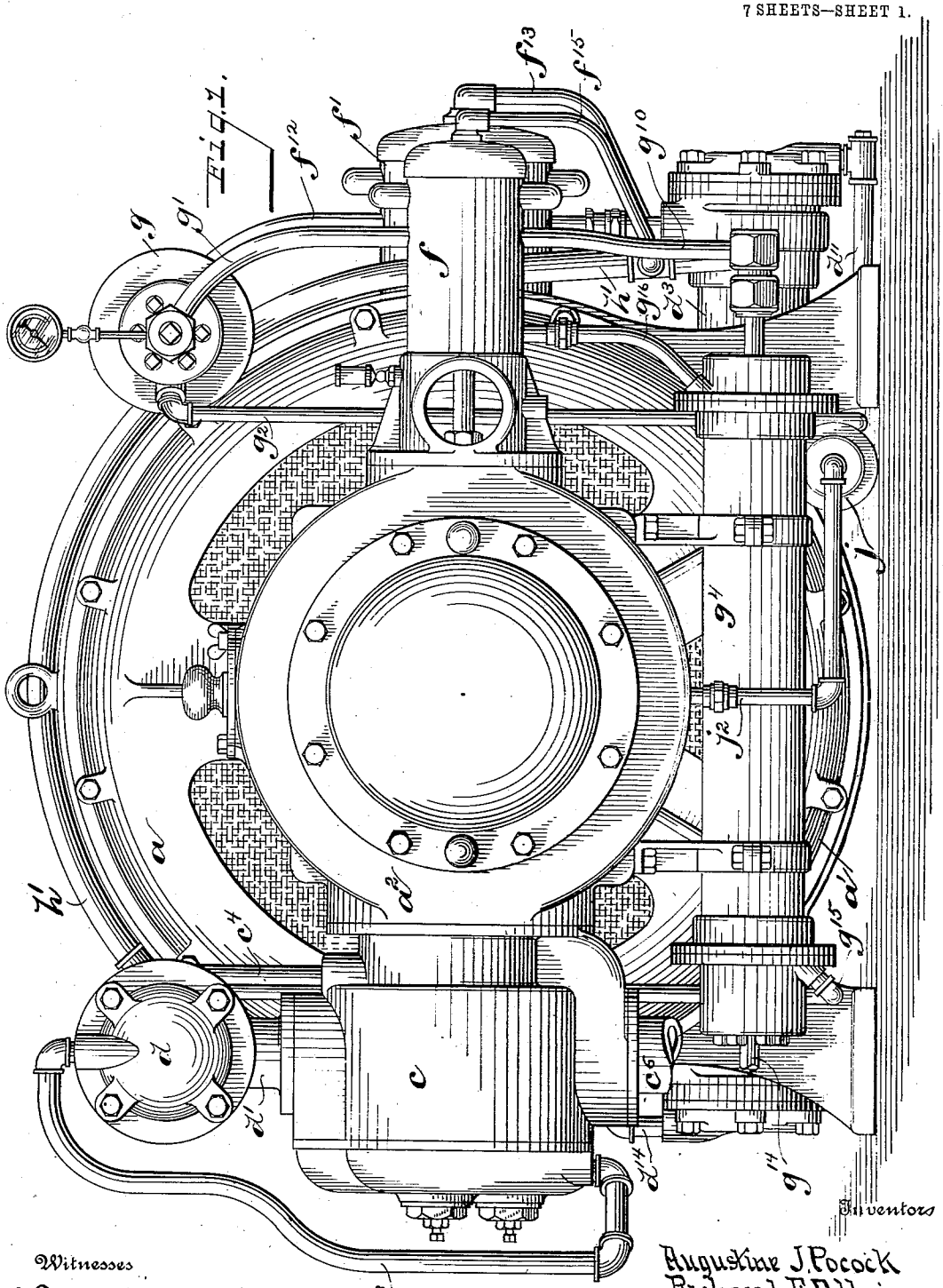
A. J. POCOCK & R. E. ALLGIRE.

ELECTRIC AIR COMPRESSOR.

APPLICATION FILED AUG. 25, 1905.

918,194. Patented Apr. 13, 1909.

7 SHEETS—SHEET 1.



Witnesses

J. Llewellyn Walker

Chas. F. Welch

Inventors

Augustine J. Pocock

Richard E. Allgire

By Staley & Bowman

Attorneys

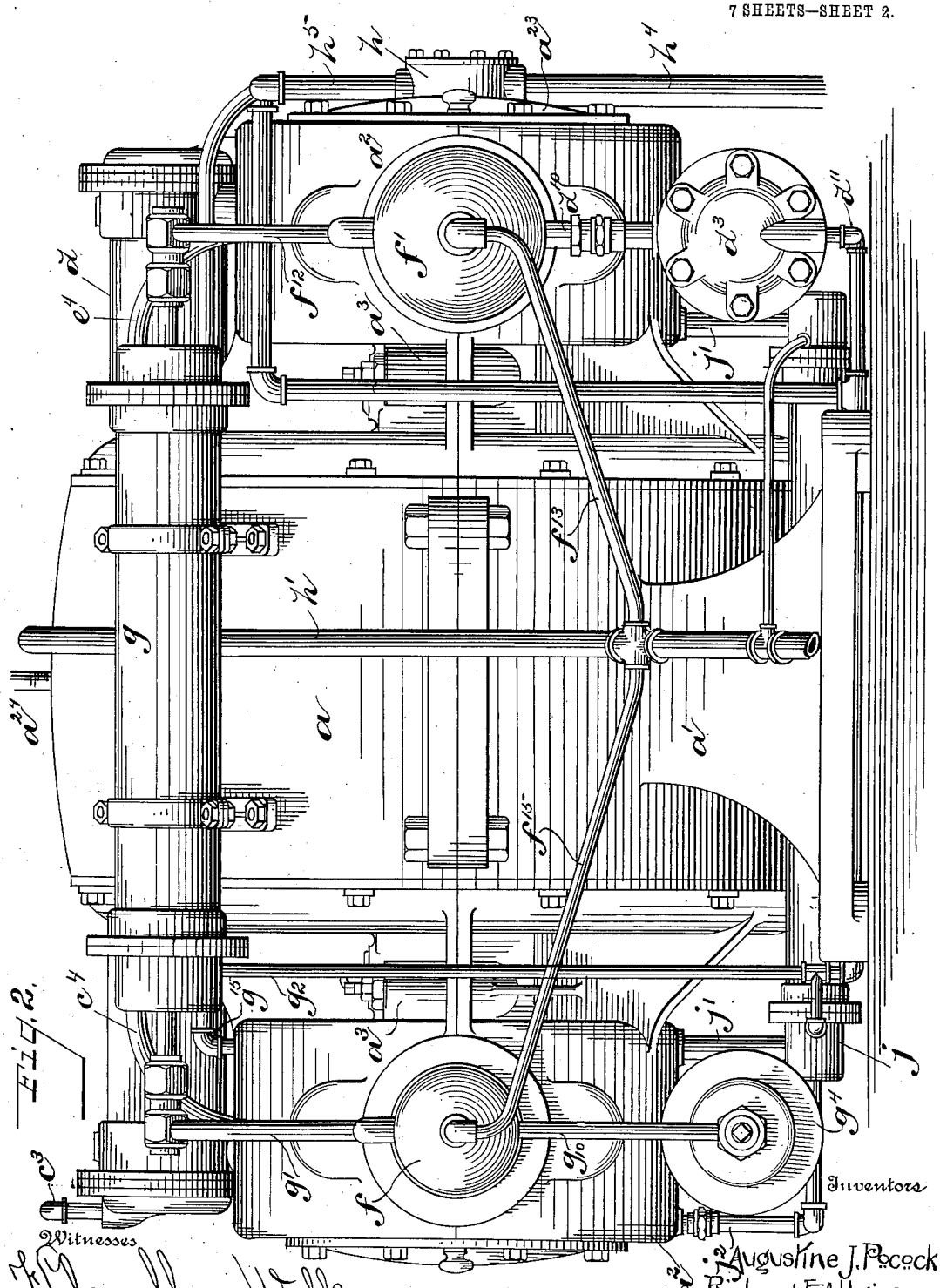
A. J. POCOCK & R. E. ALLGIRE.

ELECTRIC AIR COMPRESSOR.

APPLICATION FILED AUG. 25, 1905.

918,194. Patented Apr. 13, 1909.

7 SHEETS—SHEET 2.



Witnesses

J. Llewellyn Walker

Thos. P. Mack

Inventors

Augustine J. Pocock

Richard E. Allgire

By Staley & Bowman

Attorneys

A. J. POCOCK & R. E. ALLGIRE.

ELECTRIC AIR COMPRESSOR.

APPLICATION FILED AUG. 25, 1905.

918,194.

Patented Apr. 13, 1909.

7 SHEETS—SHEET 3.

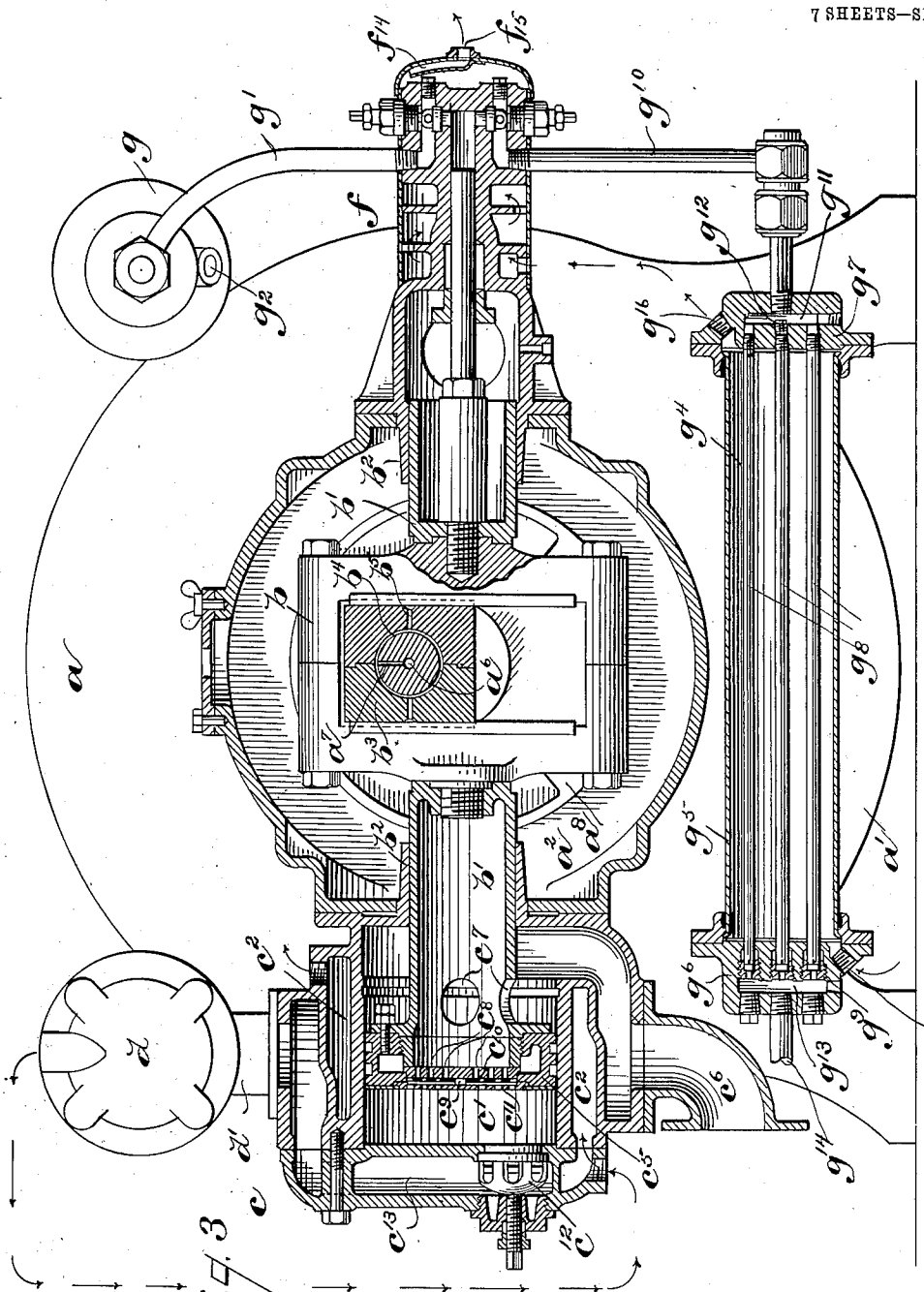


Fig. 3

Witnesses

T. Llewellyn Walker

Elias J. Welch

Inventors

Augustine J. Pocock

Richard E. Allgire

By Staley & Bowman

Attorneys

A. J. POCOCK & R. E. ALLGIRE.

ELECTRIC AIR COMPRESSOR.

APPLICATION FILED AUG. 25, 1905.

918,194. Patented Apr. 13, 1909.

7 SHEETS—SHEET 4.

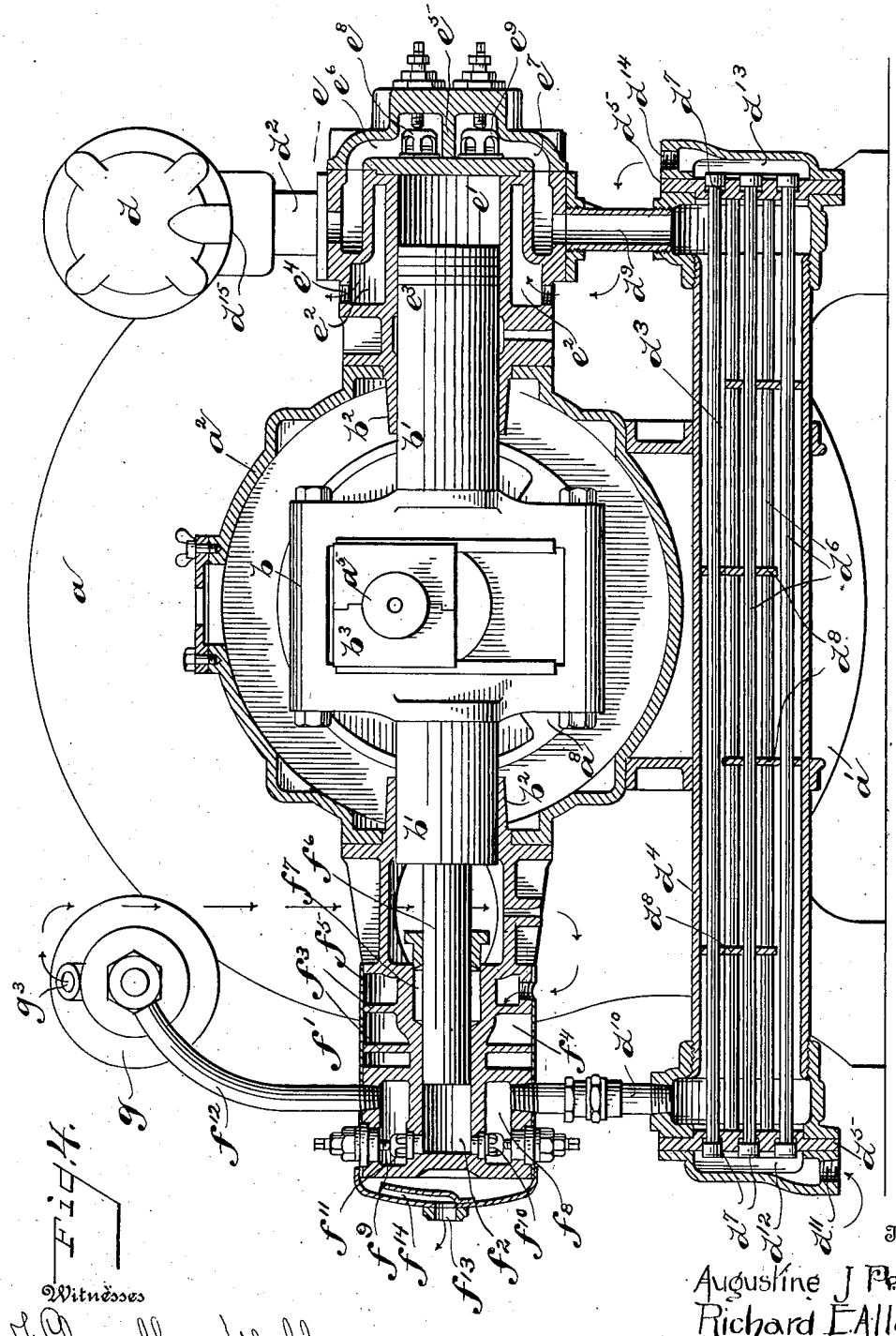


Fig. 4.

Witnesses

T. Llewellyn Walker

Chas. F. Wilch

Inventors

Augustine J Pocock

Richard E Allgire

By Staley & Bowman

Attorneys

A. J. POCOCK & R. E. ALLGIRE.

ELECTRIC AIR COMPRESSOR.

APPLICATION FILED AUG. 25, 1905.

918,194. Patented Apr. 13, 1909.

7 SHEETS—SHEET 5.

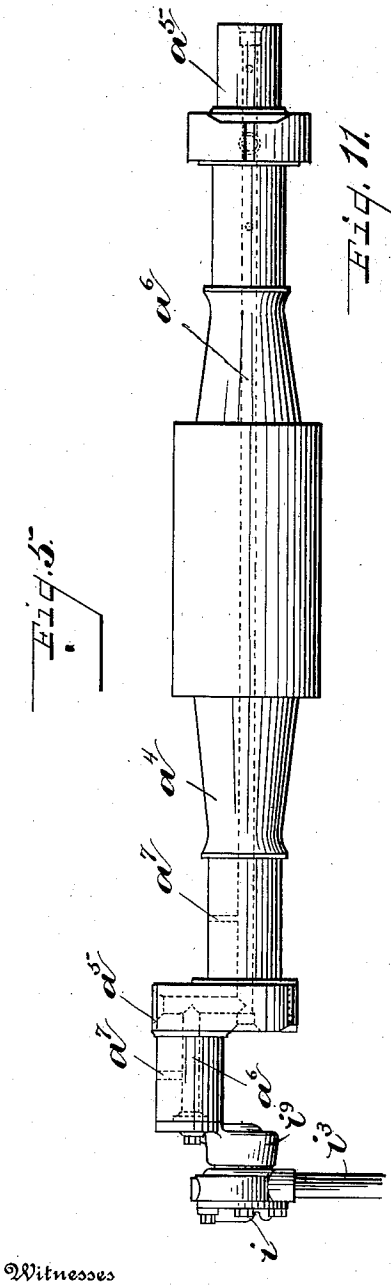


Fig. 8.

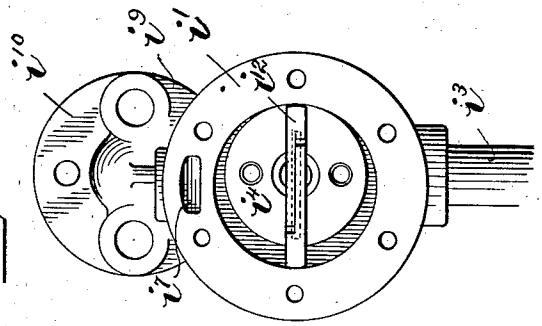


Fig. 11.

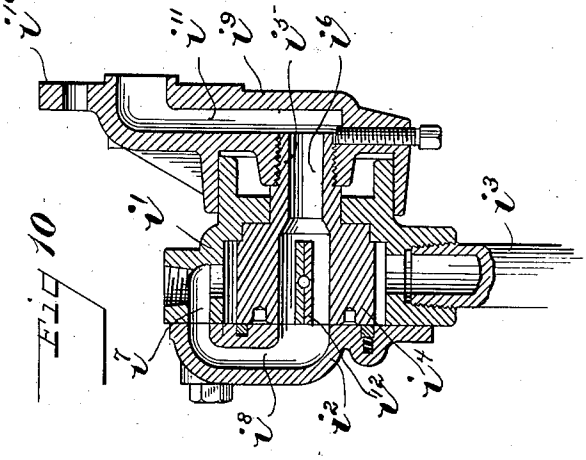


Fig. 10.

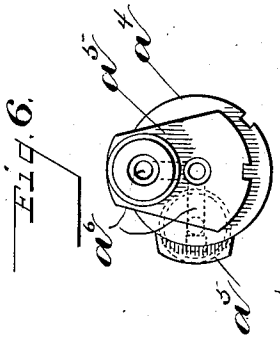


Fig. 9.

Witnesses

J. Llewellyn Walker

Chas. F. Wilch

Inventors

Augustine J. Pocock

Richard E. Allgire

By Stiley & Bowman

Attorneys

A. J. POCOCK & R. E. ALLGIRE.

ELECTRIC AIR COMPRESSOR.

APPLICATION FILED AUG. 25, 1905.

918,194.

Patented Apr. 13, 1909.

7 SHEETS—SHEET 6.

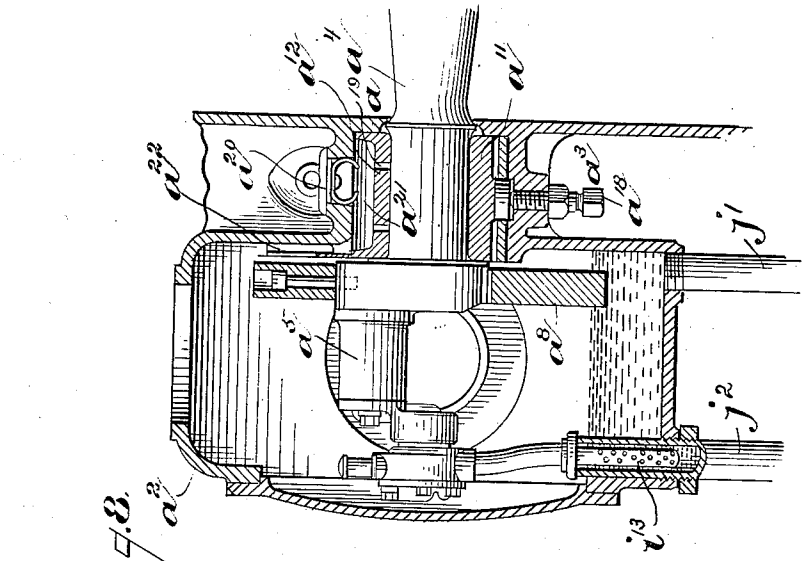


Fig. 8.

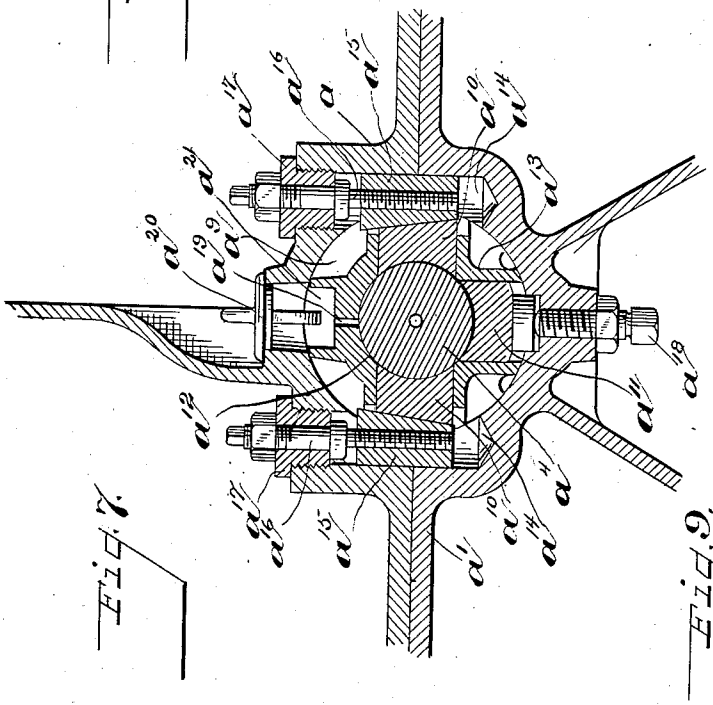


Fig. 7.

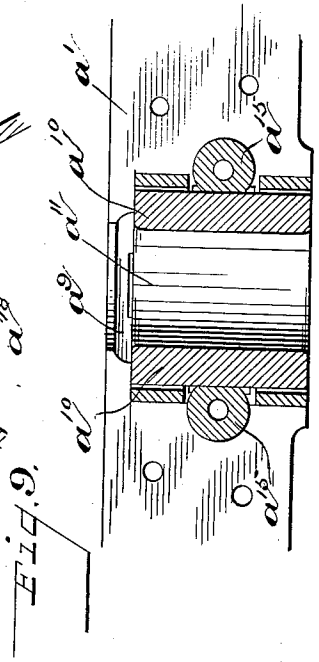


Fig. 9.

Witnesses

Llewellyn Walker

Chas. F. Welch

Inventors

Augustine J. Pocock

Richard E. Allgire

By Staley & Bowman

Attorneys

A. J. POCOCK & R. E. ALLGIRE.

ELECTRIC AIR COMPRESSOR.

APPLICATION FILED AUG. 25, 1905.

918,194.

Patented Apr. 13, 1909.

7 SHEETS—SHEET 7.

Fig. 13

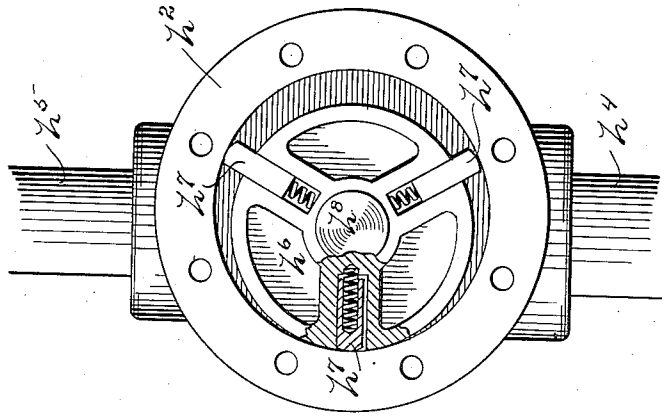
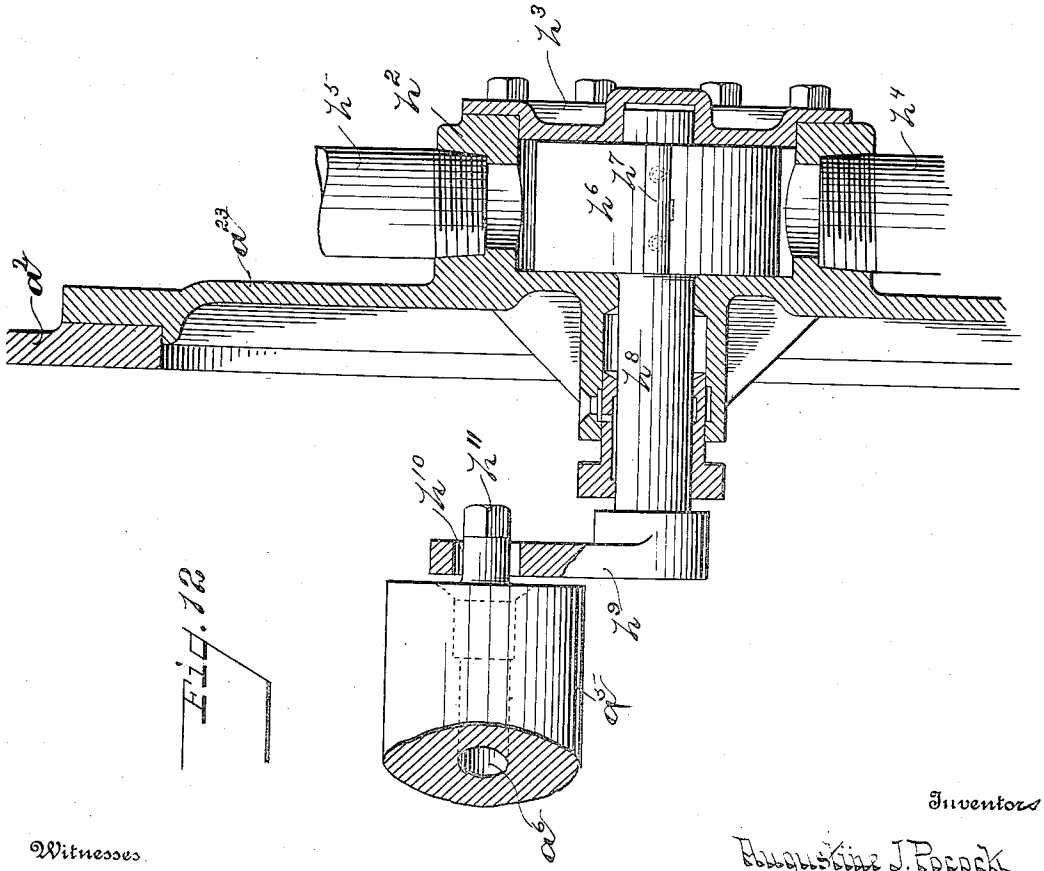


Fig. 12



Witnesses.

J. Newell Walker

Chas. J. Milch

Inventors

Augustus J. Pocock

Richard E. Allgire

By Staley & Bowman

Attorneys

UNITED STATES PATENT OFFICE.

AUGUSTINE J. POCOCK AND RICHARD E. ALLGIRE, OF DAYTON, OHIO, ASSIGNORS TO THE PLATT IRON WORKS COMPANY, OF DAYTON, OHIO, A CORPORATION OF OHIO.

ELECTRIC AIR-COMPRESSOR.

No. 918,194. Specification of Letters Patent. Patented April 13, 1909.

Application filed August 25, 1905. Serial No. 275,819.

To all whom it may concern:

Be it known that we, AUGUSTINE J. POCOCK and RICHARD E. ALLGIRE, citizens of the United States, residing at Dayton, in the county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Electric Air-Compressors, of which the following is a specification.

Our invention relates to improvements in air compressors, and particularly relates to compound, electrically driven compressors capable of developing high pressures.

The object of the invention is to provide a compressor which will be compact, comparatively light in weight, self-contained and well balanced, and so constructed that the various parts will be easily accessible.

A further object is to provide a compound compressor in which the various compression cylinders will be directly operated from an electric motor incorporated in the structure.

By the compression of air there is developed considerable heat.

A further object of the invention is to provide efficient means after each compression for absorbing the heat developed, reducing the temperature to substantially normal, and thereby reducing the bulk.

A further object is to provide a rotary or centrifugal force-pump connected directly to the motor-shaft, by which the cooling medium will be supplied to the various inter-coolers and cylinders.

A further object is to provide a structure which will permit the successful and efficient use of the Scotch cross-head, which has generally been found inefficient.

A further object is to provide means whereby oil under pressure will be supplied to the various bearings.

With the above primary and other incidental objects in view, the invention consists of the construction, mechanism and parts, or their equivalents, hereinafter described and set forth in the claims.

Referring to the drawings, Figure 1 is a side view of a four-stage electric air compressor, as viewed from the first and fourth cylinder side. Fig. 2 is an end view of same as viewed from the right in Fig. 1. Fig. 3 is a sectional view through the low and high pressure cylinders and the after-cooler. Fig. 4 is a longitudinal sectional view through the second and third cylinders and the second inter-cooler. Fig. 5 is a view of the armature and crank shaft, showing in dotted lines the oil channel therein, and the oil pump attached. Fig. 6 is an end view of same. Fig. 7 is a transverse vertical sectional view of the bearing for the armature shaft. Fig. 8 is a sectional view of the crank-casing showing the crank, the oil-pump, and a longitudinal section of the armature bearing. Fig. 9 is a horizontal view of the armature bearing. Fig. 10 is a vertical sectional view of the oil-pump. Fig. 11 is an elevation of the oil-pump with a portion of the casing removed. Fig. 12 is a vertical sectional view of the rotary pump for the cooling medium. Fig. 13 is an elevation of same with a portion of the casing removed.

Like parts are represented by similar characters of reference throughout the several views.

General description.—Briefly described, the machine is a four-stage compressor having four compression cylinders with inter-coolers arranged in circuit following the respective compression cylinders, and an after cooler following the high pressure cylinder; all arranged about and supported upon the casing of a motor which constitutes the motive power. The machine, essentially, consists of an electric motor, the armature shaft of which is extended and formed into cranks at either end, which engage Scotch cross-heads located in crank casings formed integral with the motor casing on each side of the motor and outside the armature bearings.

Secured to each of the crank casings at diametrically opposite points, and extending in opposite directions, are two compression cylinders; the respective pistons of which are secured to the corresponding cross-head and operate alternately. From each of the cylinders, except the last in the series, the air is discharged into inter-coolers, and from the last cylinder it is discharged into the after-cooler. The first and second inter-coolers are constructed substantially alike, being so constructed that the air is conducted through said inter-cooler around and outside of a series of pipes through which the cooling medium is conveyed. In the third inter-cooler and after-cooler the arrangement is reversed, and the air is conducted through a series of pipes, while the cooling medium is circulated around and outside said pipes.

The water or other cooling medium, is pumped from the source of supply directly to

each of the inter-coolers and the after-cooler by a rotary or centrifugal force-pump attached directly to one of the cranks of the armature shaft. The cooling medium from each of the inter-coolers and after-cooler is conducted through a suitable jacket about the compression cylinders immediately preceding the respective coolers in the circuit and thence to the outlet.

The armature shaft and the integral cranks are provided with central bores through which oil is forced by a rotary oil-pump secured to the crank of the armature shaft on the end opposite the pump for cooling medium. By this means, oil is supplied under pressure to the various bearings of the armature shaft and crank to the Scotch cross-heads, the brasses of which are cushioned on thin films of oil, thus obviating the necessity for a "take-up" adjustment and rendering the Scotch-cross-head efficient and successful where it has hitherto been a failure.

The air enters the first or low pressure cylinder at atmospheric pressure and temperature; in this cylinder it is compressed, and by this compression heat is developed. In its passage through the first inter-cooler the temperature is reduced to substantially normal which likewise reduces its bulk. Entering the second stage cylinder at substantially normal temperature, it is again compressed and heat again developed. This re-heating and cooling is repeated at each stage of compression to the end of the system.

Detail description; general structure.—The general structure is best illustrated by Figs. 1 and 2. The motor casing is preferably formed in two parts, an upper portion, a, and a lower portion, a^1, which are connected by suitable bolts. The crank casings, a^2, are formed integral with the motor casing and outside the bearings, a^3, of the armature shaft, a^4. The armature shaft, a^4, (Figs. 5 and 6) is formed with an integral crank, a^5, at each end thereof engaging the Scotch cross-head hereinafter described. The armature shaft and crank pins have oil channels, a^6 and a^7, which are connected with the different bearings in such manner as to supply oil to the various crank and shaft bearings under pressure from the pump secured to one of the cranks a^5. A balance disk, a^8, is secured to the armature shaft adjacent to each crank, and in addition to its balancing functions it consists in distributing oil to the armature bearings, as hereinafter described.

The armature bearings are best shown in Figs. 7, 8 and 9, and consist of the bore, a^9, intermediate the crank casing, a^2 and the motor casing into which are fitted the four bushing parts a^{10}, a^{10}, a^{11} and a^{12}, which are shaped on their adjacent sides to conform to the armature shaft; auxiliary parts, a^{13}, are provided on which the bushing parts, a^{10}, are supported. On diametrically opposite sides of the bore, a^9, are tangent bores, a^{14}, having longitudinally movable members, a^{15}, having bevel faces coincident with the beveled outer faces of the bushing parts, a^{10}. The members, a^{15}, are movable within the bores, a^{14}, by means of screws, a^{16}, mounted in plugs, a^{17}, screwed into the upper ends of the bore, a^{14}, and provided with suitable lock-nuts. By means of the screws, a^{16}, operating the members, a^{15}, the bushing parts, a^{10}, may be adjusted laterally in either direction to compensate for wear or to secure alinement of the bearings. The bushing member, a^{11}, is vertically adjustable by means of an adjusting screw, a^{18}. The bushing, a^{12}, is preferably formed with recesses as shown and is provided with oil ducts, a^{19}. An opening closed by a suitable cap, a^{20}, is provided for the inspection of the bearing.

On the inner side of the crank casing, a^2, and above the armature bearing is an inclined channel, a^{22}, leading to a point immediately above the armature shaft, and having a duct leading therefrom to the recess, a^{21}, of the bushing part, a^{12}. Oil is contained in the lower part of the casing, a^2, at a depth above the periphery of the balance disk, a^8. As the disk, a^8, revolves, the oil is carried upward and thrown against the top and sides of the crank casing, a^2; as it descends it is caught by the channel, a^{22}, and conducted within the armature bearing. Within the crank casing, a^2, are located the Scotch cross-heads, b, having the guides, b^1, which are supported by suitable bearings, b^2, secured to the crank casing at diametrically opposite points.

Within the bore of the crank brasses, b^3, is a peripheral groove, b^4, registering with the oil duct of the crank pin, and from which lead oil ducts, b^5, to the bearing surfaces of the brasses. By this means, a generous supply of oil is conducted under pressure to the bearing surfaces forming a thin film of oil upon which the brasses cushion. Under such conditions, there will be no perceptible wear of the parts and such wear as may possibly occur will be compensated for by a thicker film of oil.

The Scotch crosshead has not been a popular form of construction heretofore, for the reason that the slight clearance of the sliding block in the yoke, which is necessary for a sliding fit has usually allowed the sliding block or wrist-brass to hammer in the yoke, making excessive noise and causing a deterioration of the parts. However, by the construction above described, wherein oil under pressure is supplied to cushion, adjust and lubricate the working parts, the Scotch crosshead is rendered successful and efficient.

Secured to the crank casing, a^2, upon one side of the motor casing, and extending in diametrically opposite directions, are the low and high compression cylinders, c and f,

respectively. Connected in a similar manner to the crank casing on the opposite side of the motor casing, a—a^1, are the second and third stage compression cylinders, e and f^1, respectively.

The first and third stage intercoolers, d and g, are secured by suitable brackets, to the upper portion, a, of the motor casing. The second stage intercooler, d^3, and the aftercooler, g^4, are secured in suitable brackets to the bottom of the respective crank casings, a^2.

In Fig. 2 is shown the centrifugal pump h by which the cooling medium is supplied to the various intercoolers and aftercooler. The outlet conduit from said coolers is indicated at h^1. It will also be noted that the cooling medium is introduced into each of the various cylinders and coolers at substantially the lowest point and withdrawn therefrom at the highest point, to avoid the possibility of air collecting in the water jackets and cooler chambers.

An oil cooler, j, is provided with suitable connections to the respective crank casings, a^2, and the oil pump, i.

All the above mentioned parts will be hereinafter fully described in detail in regular order.

Low pressure cylinder.—The low pressure cylinder, c, consists essentially of the cylinder, c^1, surrounded by the water space or jacket, c^2, through which is conducted a current of water for absorbing the heat developed during the operation. The water is conducted to the water jacket, c^2, through the pipe, c^3, from the outlet of the first intercooler, d, and after circulating about the cylinder, c^1, is conducted through the outlet pipe, c^4, to the discharge pipe, h^1; the course of the water being indicated by the arrows. The piston, c^5, of the low pressure cylinder is attached to and in reality forms an extension of the guide, b^1, of the cross-head, b. The air intake is indicated by c^6. The air passes from the intake, c^6, into the interior of the barrel, b^1, through openings, c^7, and thence through a suitable valve in the piston-head to the cylinder, c^1. The preferred valve is an inertia valve as shown in Fig. 3. In this construction the piston head is provided with a series of openings, c^8, and a central stud, c^9, on which is mounted a disk, c^{10}, having a series of openings offset in the arrangement with the openings, c^8. A keeper-plate, c^{11}, is also secured to the piston and provided with a series of openings which register with those of the disk, c^{10}. The keeper-plate, c^{11}, is somewhat separated from the piston-head forming a chamber in which the disk, c^{10}, is located and permitted a slight movement longitudinal to the piston. In operation, as the piston moves on the return stroke, the inertia will cause the disk, c^{10}, to move into proximity with the keeper-plate, c^{11}, with the openings of which the disk openings register and the air will have free passage through the openings, c^8, and then through the openings of the disk and keeper-plate to the cylinder, c^1. Upon the forward stroke of the piston, the disk, c^{10}, will be moved by inertia into contact with the piston head, and inasmuch as the openings in said parts are offset, will form a solid head. From the cylinder, c^1, the air is forced through one or more outlet valves, c^{12}, into a passage or conduit, c^{13}, formed integral with the cylinder-head, through which it is conducted to the inlet, d^1, of the first intercooler, d. In the drawings, but one outlet valve c^{12}, is shown; however, three such valves are preferably employed.

First and second intercoolers.—Inasmuch as the construction of the first and second intercoolers, d and d^3, respectively, is identical, a detailed description of one will be applicable to both. In Fig. 4, there is shown a longitudinal section of the second intercooler, d^3. This intercooler consists of a cylindrical casing, d^4, provided at opposite ends with heads, d^5, in which are supported the opposite extremities of a series of pipes, d^6. To permit the unequal expansion and contraction of the parts, the pipes, d^6, are loosely connected in the heads, d^5, and each pipe is provided with packing glands, d^7. The casing, d^4, contains a series of baffle-plates, d^8, by which a tortuous passage is given to the air which is introduced through the inlet-pipe, d^9, from the second compression cylinder hereinafter described, and withdrawn through the outlet, d^{10}, to the third compression cylinder. The water is introduced through the inlet, d^{11}, (Fig. 4), to a chamber, d^{12}, adjacent to the head, d^5, and communicating with the pipes, d^6. The water is passed from the chamber, d^{12}, through the pipes, d^6, around which the air is circulated, and in a direction contrary to the current of air, to a chamber, d^{13}, at the opposite end of the intercooler from which it passes through the outlet pipe, d^{14}, to the water-jacket of the second stage compression cylinder.

Referring to the first intercooler, the construction is similar to that just described. The air is introduced to the first intercooler from the first compression cylinder through the inlet, d^1, and from the intercooler to the second cylinder through the outlet, d^2. The water is passed in the reverse direction from the water-inlet, d^{15}, to the outlet-pipe, c^3, by which it is conducted to the water jacket of the first stage cylinder, as before mentioned. There are provided for the various intercoolers suitable drains (not shown) of ordinary construction, for removing moisture which may be precipitated through condensation upon the cooling of the air.

Second stage cylinder.—The second com-

pression cylinder e is secured to the crank casing, a^3, on the side of the structure opposite the low pressure cylinder, c. It consists of the cylinder, e^1, surrounded by the water jacket, e^2. The piston, e^3, is formed integral with the barrel, b^1, of the Scotch cross-head, b. The water supply for the water jacket, e^2, is conducted (as indicated by the arrows in Fig. 4) from the intercooler, d^3, through said jacket and is discharged from the outlet, e^4, to the common discharge pipe, h^1.

Formed in the cylinder head and a portion of the cylinder body is an air conduit divided by a partition, e^5, into an inlet conduit, e^6, and an outlet conduit, e^7. Between the inlet conduit, e^6, and the cylinder, e^1, is located one or more inlet valves, e^8, and leading from said cylinder and the outlet conduit, e^7, is an equal number of outlet valves, e^9. In the drawings, but one inlet and one outlet valve is shown, however in practice two of each of said valves are preferably employed.

Upon the rearward stroke of the piston, e^3, the air is drawn from the first intercooler, d, through the outlet, d^2, and the inlet conduit, e^6, and valve, e^8, to the cylinder, e^1 upon the forward movement of the piston e^3, the air is ejected through the outlet valve, e^9, and conduit, e^7, and the inlet pipe, d^9, of the second intercooler into said cooler through which it passes as before described to the third compression cylinder.

Third stage and high pressure cylinders.—The third stage and high pressure cylinders being similar in construction, and differing only in size, a detail description of one will be equally applicable to the other. The third stage cylinder, f^1, is secured to the crank casing, a^2, diametrically opposite the second stage cylinder, e. It consists of a casting having a central bore, f^2, forming the cylinder proper, and a series of peripheral flanges, f^3, which form baffle-plates of a water jacket, f^4, formed by the inclosing jacket, f^5. The piston, f^6, is attached to the cross-head, b, and is provided with a packing gland, f^7. An inlet conduit, f^8, and an outlet conduit, f^9, communicating with the bore, f^2, by means of inlet and outlet valves, f^{10}—f^{11}, respectively, are formed in the cylinder casting. Upon the rearward stroke of the piston, f^6, the air is drawn from the second intercooler, d^4, through its outlet pipe, d^{10}, and the inlet conduit, f^8, and inlet valve, f^{10}, to the bore, f^2, and upon the forward stroke of the piston is ejected through the outlet valve, f^{11}, and outlet conduit, f^9, to the pipe, f^{12}, by which it is conducted to the third intercooler, g. The cooling medium for the third stage cylinder is conducted, as shown by arrows in Fig. 4, from the third intercooler, g, through the water jacket of said cylinder and discharged through the outlet, f^{13}, to the common discharge pipe, h^1. It will be noted that while the discharge opening is centrally located with regard to the end of the cylinder, a conduit, f^{14}, extends within the water jacket, f^5, in order that the discharge water will be drawn from substantially the highest point of the jacket.

The third intercooler and aftercooler.—The air passing through the pipe, f^{12}, from the third cylinder enters the third intercooler, g, from which it is conducted through the connecting pipe, g^1, to the high pressure cylinder, f. The cooling medium for the third cooler and compression chamber enters the cooler at g^2, and after leaving the cooler is conducted through the outlet, g^3, to the third cylinder, as indicated by arrows, Fig. 4, from which it is discharged, as before mentioned, through the outlet, f^{13}.

Since the construction of the third stage cooler, g, and the aftercooler, g^4, is similar, a detailed description of the latter with reference to the longitudinal section shown in Fig. 3 will apply equally to both. The aftercooler, g^4, comprises the cylindrical casing, g^5, having secured thereto the recessed or chambered-heads g^6—g^7. A series of pipes, g^8, are located within the casing, g^5, with their ends secured in the head, g^7, while the opposite ends are loosely mounted in the head, g^6, to permit the unequal expansion and contraction of the various parts. The loose ends of the pipes, g^8, are provided with packing glands, g^9. The air is conducted to the aftercooler from the high pressure cylinder, f, through a pipe, g^{10}, and enters a chamber, g^{11}, in the head, g^7, which communicates with the respective pipes, g^8. The pipe, g^8, directly opposite the air intake, is provided with a reducing plug, g^{12}, in order that the air may be distributed to the other pipes and prevented from rushing through the central pipe. From the respective pipes, g^8, the air empties into a chamber, g^{13}, in the head, g^6, from which leads the offtake g^{14}, to the compressed air reservoir. The cooling medium is introduced to the aftercooler through the inlet, g^{15}, and is withdrawn through g^{16}, and is conducted, as indicated by arrows in Fig. 3, about the high-pressure cylinder, f, which corresponds to the description before made of the third stage cylinder. From the high-pressure cylinder, the cooling medium is discharged through the outlet, f^{15}, to the common discharge pipe, h^1.

Pump for cooling medium.—The water used as a cooling medium is supplied to the various coolers and corresponding cylinders under pressure by means of a rotary pump, h, secured to the cover, a^{23}, of one of the crank casings, a^2. The pump, h, is illustrated in Figs. 12 and 13 of the drawings. It consists of the circular casing, h^2, preferably formed integral with the cover, a^{23}, and fitted with the cover, h^3. An intake pipe, h^4, leading from the source of supply and an off-take pipe, h^5, from which the water is distributed,

by various branches, to the respective coolers, are connected with the casing, h^2, at diametrically opposite points. Eccentrically mounted within the casing, h^2, is a rotary member, h^6, provided with spring pressed blades, h^7, which at all times are pressed in contact with the inner periphery of the casing, h^2. The rotary member, h^6, is provided with a shaft, h^8, mounted in a suitable bearing in the cover, a^{23}, and extending within the casing, a^2. The casing, h^2, and rotary member, h^6, are so located that the axial line of the shaft, h^8, will be coincident with that of the armature shaft, a^4.

Secured to the inner end of the shaft, h^8, is a crank arm, h^9, having therein an opening preferably a slot, as at h^{10}, to engage a stud, h^{11}, in the end of the crank, a^5. By this means, the rotary member, h^6, is driven in unison with the armature shaft, a^4, and by the action of the blades, h^7, the water is drawn in through the intake, h^4, and discharged through the offtake, h^5, to the various coolers.

Oil-pump and cooler.—As before mentioned, the armature-shaft, a^4, and cranks, a^5, are provided with central bores, a^6, and lateral ducts, a^7, by which oil is supplied, under pressure, to the various bearings from a pump, i, connected to one of the cranks, a^5, as shown in Figs. 5 and 8. The pump, i, consists of the circular casing, i^1, having the cap, i^2, fitted thereto. An intake, i^3, leads into the casing. Within the casing, i^1 is eccentrically mounted in suitable bearings, a rotary member i^4, having formed integral therewith a shaft, i^5. A central bore, i^6, extends longitudinally through the rotary member, i^4, and shaft, i^5. There are carried by the rotary member, i^4, spring actuated blades, which continuously contact the inner walls of the casing, i^1, and operate in a manner similar to the blades, h^7, of the water pump, h, to draw the oil through the intake, i^3, and discharge it through an opening, i^7, in the casing, i^1, located diametrically opposite the intake, i^3. The opening, i^7, in the casing, i^1, registers with a conduit, i^8, in the cap, i^2, which conduit in turn registers with the bore i^9 of the rotary member, i^5. Secured to the shaft, i^5, is a crank member, i^9, having an enlarged end, i^{11}, adapted to be secured to the end of the crank pin of one of the cranks, a^5, as in Figs. 5 and 8. The throw of the crank member, i^9, is equal to that of the crank, a^5, whereby the body of the oil pump i will remain stationary while the crank member, i^9, revolves with the crank, a^5. Within the crank member, i^9, is a conduit, i^{11}, connecting the bore, i^6, of the shaft, i^5, and the bore, a^6, of the crank, a^5. Thus as the armature shaft a^4 rotates, the rotary member, i^4, through the crank member, i^9, will rotate in unison and the oil will be drawn through the intake-pipe, i^3, and discharged through the opening, i^7, thence through the conduit, i^8, and the bore, i^6, of the rotary member, i^4, to the conduit, i^{11}, by which it is conducted to the bore, a^6, of the crank, a^5. The oil supply is located in the lower part of the crank casings, a^2. A portion of the oil forced by the pump, i, through the armature shaft, a^4, is discharged into the casing, a^2, on the side opposite said pump, which casing would, eventually, receive the entire oil supply if means were not provided for returning it to the pump, i. To maintain the oil in equilibrium, and further cool the oil which becomes heated in its passage through the bearings, the oil cooler, j, is provided, extending below the portion, a^1, of the motor frame, and having connections j^1 with each of the casings, a^2. In order that the supply of oil to the pump, i, may be cool, there is provided a pipe, j^2, leading from the oil-cooler, j, to a point within the casing, a^1. Into the pipe, j^2 extends the perforated end, i^{13}, of the oil intake, i^3. By this means, the oil supplied to the armature and crosshead bearings is drawn direct from the cooler, j. The construction of the oil-cooler, j, is similar to that of the aftercooler, g^1; the oil being circulated through the pipes while the water is passed in the opposite direction around said pipes.

There is thus provided a structure which is efficient in operation, compact in construction, so arranged that the working parts are accessible and self-contained, so balanced that it may be handled by an eye-bolt, a^{24}, secured to the top of the motor casing.

Having thus described our invention, we claim:—

1. In an air compressor, the arrangement of the circuits of air and cooling medium by arranging a plurality of cooling devices with a plurality of compression devices and a pump and conduits directing the cooling medium from the pump direct to each cooling device, means for discharging the cooling medium from each cooler to the compressor jacket, and means for directing the air from each compressor cylinder to a cooler in a direction opposite to that of the cooling medium circuit, substantially as specified.

2. In an air compressor, the arrangement of the air and cooling medium circuits comprising a plurality of coolers and a plurality of compression cylinders, means for forcing the cooling medium direct to each cooler, and means for conducting the cooling medium through each cooler and thereafter to its associated compressor, and means directing the air from each compressor cylinder through its associated cooler in a direction reverse to that of the cooling medium circuit, and means for discharging the air from the high stage compressor cylinder to a reservoir, substantially as specified.

3. In an air compressor, the arrangement

of the air and cooling medium circuits by associating a plurality of multiple stage compressors with associated cooling devices for each compressor, a plurality of inclosed and uninclosed conduits within each cooler for the air and cooling medium, means for forcing the cooling medium through said inclosed conduits in the low stage cooler and through the uninclosed conduits in the higher stage cooling devices, and means for directing the air from a compressor cylinder to its associated cooling devices in a direction opposite to that of the cooling medium circuit, substantially as specified.

4. In an air compressor, the arrangement of the air and cooling medium circuits by combining a plurality of multiple stage compressors with a plurality of coolers, a pump for forcing the cooling medium direct to each cooling device, and separate conduits in the cooling device for the air and cooling medium, and means conducting the cooling medium for the low stage cooling devices through one set of said conduits and the air from the compressor cylinder through the other set of conduits in a direction opposite to that of the cooling medium circuit and in the higher stage cooling devices, means for forcing the cooling medium through the conduits corresponding to the air conduits in the low stage cooler, and the air through the conduits corresponding to the cooling medium conduits of said low stage cooler, substantially as specified.

5. In an air compressor, the arrangement of the air and cooling medium circuits by combining a plurality of compressors with a plurality of coolers, a plurality of pipes within the coolers, and a plurality of conduits additional to said pipes, a pump for forcing the cooling medium direct to each cooler and through the pipes in the first stage coolers, and means for directing air through the other conduits in the low stage cooler in a direction opposite to that of the cooling medium circuit, and means for directing the air through the pipes in higher stage coolers and for forcing the cooling medium through the other conduits in a direction opposite to that of the air circuits, substantially as specified.

6. In an air compressor, the arrangement of the cooling medium and air circuits by combining a plurality of compressors with a plurality of coolers, a pump for forcing the cooling medium direct to each cooler and into the bottom thereof and directing the cooling medium from the top of the cooler to its associated compressor, and means for directing the air through said cooler in a direction opposite to that of the circuit of cooling medium, and means for thereafter directing the air to the next higher stage compressor, substantially as specified.

7. In an air compressor, the combination of an electric motor with a main casing secured to said motor, a plurality of compressors, a plurality of coolers, and a pump coöperating with said coolers operated by said motor and directing the cooling medium direct to each cooler, a plurality of conduits connecting the compressors and coolers, and means for entirely supporting all of said devices from the main casing of said motor, substantially as specified.

8. In an air compressor, a casing, an armature shaft, an electric motor secured thereto, a series of compression chambers connected to said armature shaft, and cooling devices following in circuit each of said compression chambers, and a pump located on said casing and operated by the armature shaft of said motor for supplying a cooling medium to each of said cooling devices, substantially as specified.

9. In an air compressor, an electric motor, compression chambers supported upon the motor casing, cranks upon the armature shaft of said motor, driving connections from said cranks to the pistons of said cylinders, an internal oil channel extending through said armature and cranks, lateral ducts leading from said channel, and an oil pump driven by said armature shaft and connected to said internal oil channel for supplying oil, under pressure, through said channel and ducts to the various bearings, substantially as specified.

10. In an air compressor, an electric motor, oppositely disposed compression chambers and pistons supported on the casing thereof, a crank formed on the armature shaft of said motor, a Scotch crosshead engaging said crank and operating the pistons of said compression chambers, means for supplying oil under pressure to said crosshead through said crank to cushion and adjust the brasses of said crosshead, and compensate for the wear thereof by a film of oil of greater or less thickness, substantially as specified.

11. In an air compressor, an electric motor, a plurality of compression chambers operated by said motor, intercoolers connected in circuit with and intermediate said chambers, an aftercooler following in circuit the high pressure chamber, means for supplying cooling medium directly to each of the respective intercoolers and aftercooler, means for conducting the cooling medium from each of the intercoolers and aftercooler about the compression chamber preceding in circuit the respective coolers, substantially as specified.

12. In an air compressor, an electric motor and the armature shaft thereof, a plurality of compression chambers, pistons therefor connected with said armature shaft, intercoolers intermediate said chambers, a pump operated by said armature shaft for

supplying cooling medium to said intercoolers, conduits located in said armature shaft connecting with the bearings, and an oil pump driven by said armature shaft and having a connection with said conduits, substantially as specified.

13. In an air compressor, an electric motor, a plurality of compression chambers supported on the motor casing, cranks on the armature shaft of said motor, direct connections between said cranks and the pistons of the respective compression chambers, intercoolers intermediate said chambers, a pump directly connected to and operated by the armature shaft for supplying cooling medium to said intercooler, a pump directly connected to the opposite end of the armature shaft for supplying oil, under pressure, to the various bearings, substantially as specified.

14. In an air compressor, an electric motor, a crank located on the armature shaft thereof, oppositely disposed compression chambers, a Scotch crosshead engaged by the cranks of the armature shaft, pistons for said compression chambers rigidly connected to said crosshead, an oil pump connected to and operated by said crank, a conduit in said crank leading from said pump, a lateral duct leading from said conduit to the bearing of the crank, and crosshead brasses, oil conduits in the crosshead brasses leading to the bearings of said brasses and crosshead, substantially as specified.

15. In an air compressor, an electric motor, oppositely disposed compression chambers, a crank formed on the armature shaft of said motor, a Scotch crosshead engaged by said crank, the brasses of which are devoid of mechanical adjustment, pistons connected to said crosshead, a pump operated by said armature shaft for supplying oil, under pressure, to said crosshead, whereby the bearings of the brasses on the crosshead will be automatically adjusted by the thickness of the intervening film of oil, substantially as specified.

16. In an air compressor, an electric motor, a crank formed on the armature shaft of said motor, a crank casing within which said crank revolves, and adapted to form an oil reservoir secured to the motor casing, and adjacent to the armature bearing, compression chambers supported on said crank casing, pistons operating within said chambers, and actuated by said crank, a balance disk secured to the armature shaft with a portion of its periphery submerged in the oil within the crank casing, an oil collecting conduit secured to the interior of the crank casing, and leading to the armature bearing, substantially as specified.

17. In an air compressor, a compression chamber, a cooling jacket surrounding said chamber, an intercooler, a piston operating with said compression chamber, means for reciprocating said piston, a chamber within said piston open to the air intake, a valve in the head of said piston, leading from said chamber to the compression chamber, an air conduit leading from the compression chamber to the intercooler, an outlet valve from said compression chamber into said air conduit, a conduit for cooling medium leading from the intercooler to the cooling jacket, and a discharge conduit leading from said cooling jacket, substantially as specified.

18. In an air compressor, a plurality of compression chambers, pistons therefor, means for actuating said pistons, a cooling jacket surrounding said chambers, an intercooler in circuit between said chambers, an air conduit leading from the first compression chamber of the series to said intercooler an air conduit leading from said intercooler to the second compression chamber of the series, a supply for cooling medium, a conduit leading therefrom to said intercooler, means for circulating the cooling medium through the intercooler in a direction contrary to that of the air, a conduit leading from the intercooler to the cooling jacket of the first compression chamber of the series, and a discharge conduit leading from said cooling jacket, substantially as specified.

19. In an air compressor, a compression chamber, a piston therefor, means for actuating said piston, air cooling devices connected in circuit with said compression chamber and on opposite sides thereof, an air conduit formed in the head of said compression chamber and communicating with said cooling devices, a partition dividing said conduit into an intake and an outlet portion, an intake valve and an outlet valve in the head of said compression chamber, and communicating with the respective portions of said conduit, substantially as specified.

20. In an air compressor, a compression chamber, a piston therefor, means for actuating said piston, an air inlet and an air outlet in said compression chamber, a cooling jacket surrounding said compression chamber, baffle-plates in said cooling jacket formed integral with said compression chamber, an inlet for cooling medium to said cooling jacket, an outlet leading from substantially the highest point of said jacket, substantially as specified.

21. In an air compressor, a compression chamber, a Scotch crosshead, a piston connected to said crosshead and operating within said compression chamber, air inlet and air outlet valves in said chamber, peripheral flanges on said compression chamber, a jacket surrounding said chamber, and flanges forming a cooling chamber within which said flanges constitute baffle-plates, and an inlet and an outlet in said cooling jacket, substantially as specified.

22. In an air compressor, compression

chambers, operating devices therefor, an electric motor, a crank formed on the armature shaft of said motor, an oil channel through said crank and shaft, a rotary pump, a crank to operate said pump secured to the armature shaft crank, and an oil channel from the discharge of said pump through said pump crank to the oil channel of said armature crank, substantially as specified.

23. In an air compressor, a plurality of air cooling devices, a plurality of compression chambers, means for actuating the pistons of said compression chambers, a pump for supplying cooling medium, independent conduits leading to each of the air cooling devices, a conduit leading from each of the respective cooling devices to the corresponding compression chamber, and a discharge conduit leading from each of the compression chambers, substantially as specified.

24. In an air compressor, compression chambers, cooling devices, an electric motor, a crank formed on the armature shaft of said motor, a rotary pump, a crank for operating said pump, connected to the said crank on the armature shaft, substantially as specified.

25. In an air compressor, a motor, oppositely disposed compression chambers and pistons supported in proximity thereto, a crank formed on the shaft of said motor, a Scotch crosshead engaging said crank and operating the pistons of said compression chambers, oil conduits in said shaft and crank connecting with said crosshead and its bearings, and an oil pump driven by said shaft and connected with said oil conduit for supplying oil under pressure to said crosshead to cushion and adjust the brasses of said crosshead and compensate for the wear thereof by a film of oil of greater or less thickness, substantially as specified.

26. In an air compressor, an electric motor, a plurality of compression chambers, each of said compression chambers having a water jacket, a piston located in each chamber actuated by said motor, intercoolers intermediate said chambers, a pump operated by said motor for supplying a cooling medium to said intercoolers and to said water jackets, and an oil pump operated by said motor for supplying a continuous flow of oil to the working parts, substantially as specified.

In testimony whereof, we have hereunto set our hands this 14" day of August A. D. 1905.

AUGUSTINE J. POCOCK.
RICHARD E. ALLGIRE.

Witnesses:
E. F. GALLAUDET,
H. J. MARTIN.