

M. RIESNER.  
AIR COMPRESSOR.  
APPLICATION FILED MAR. 4, 1915.

Patented June 6, 1916.  
2 SHEETS—SHEET 1.

1,185,942.

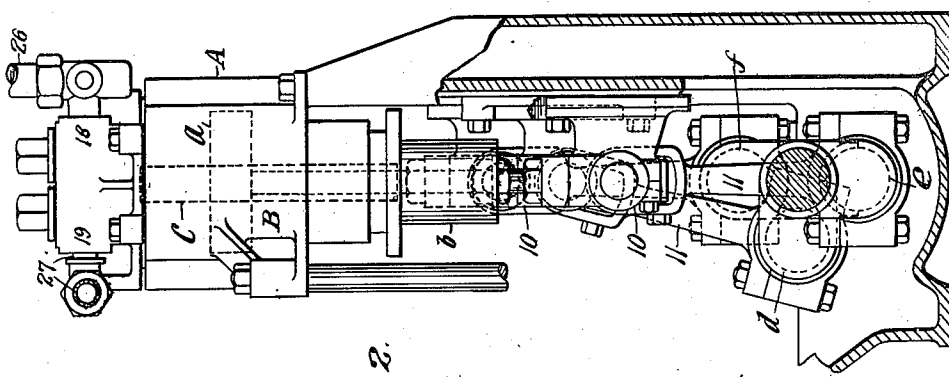


Fig. 2.

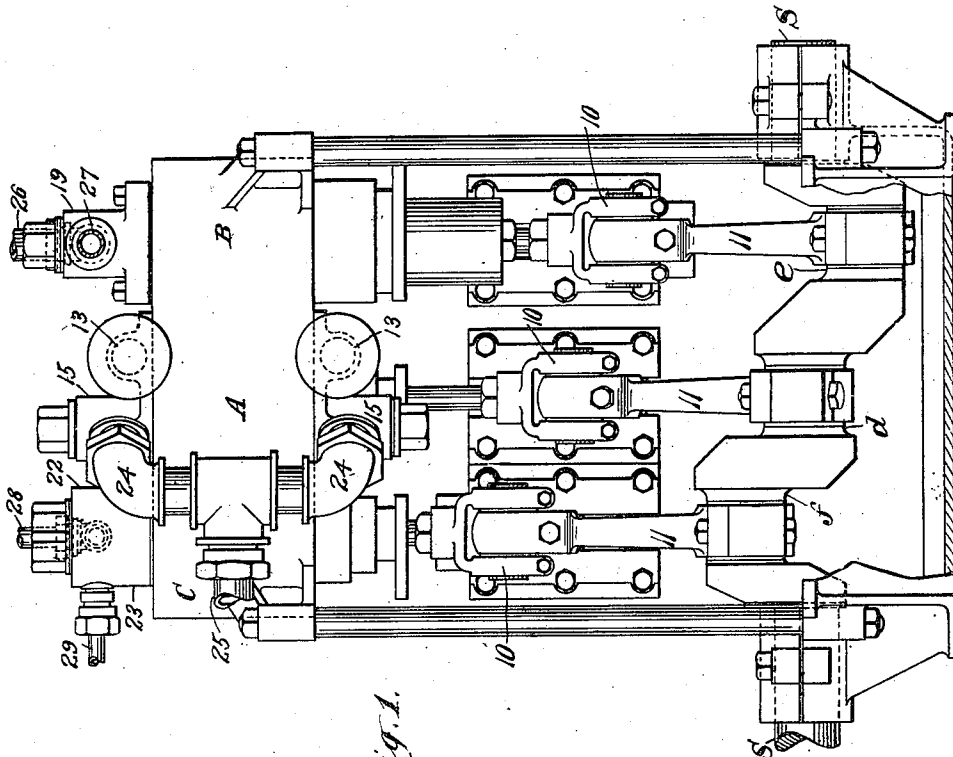


Fig. 1.

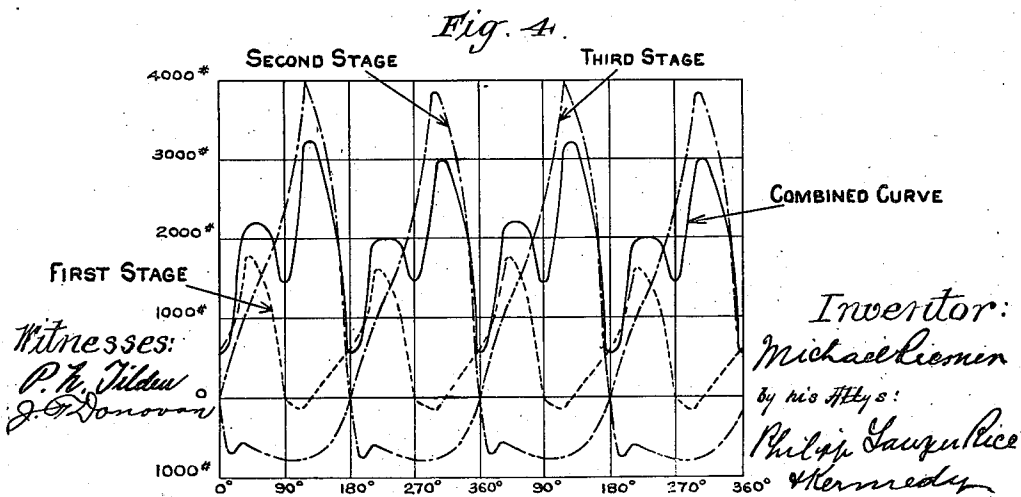
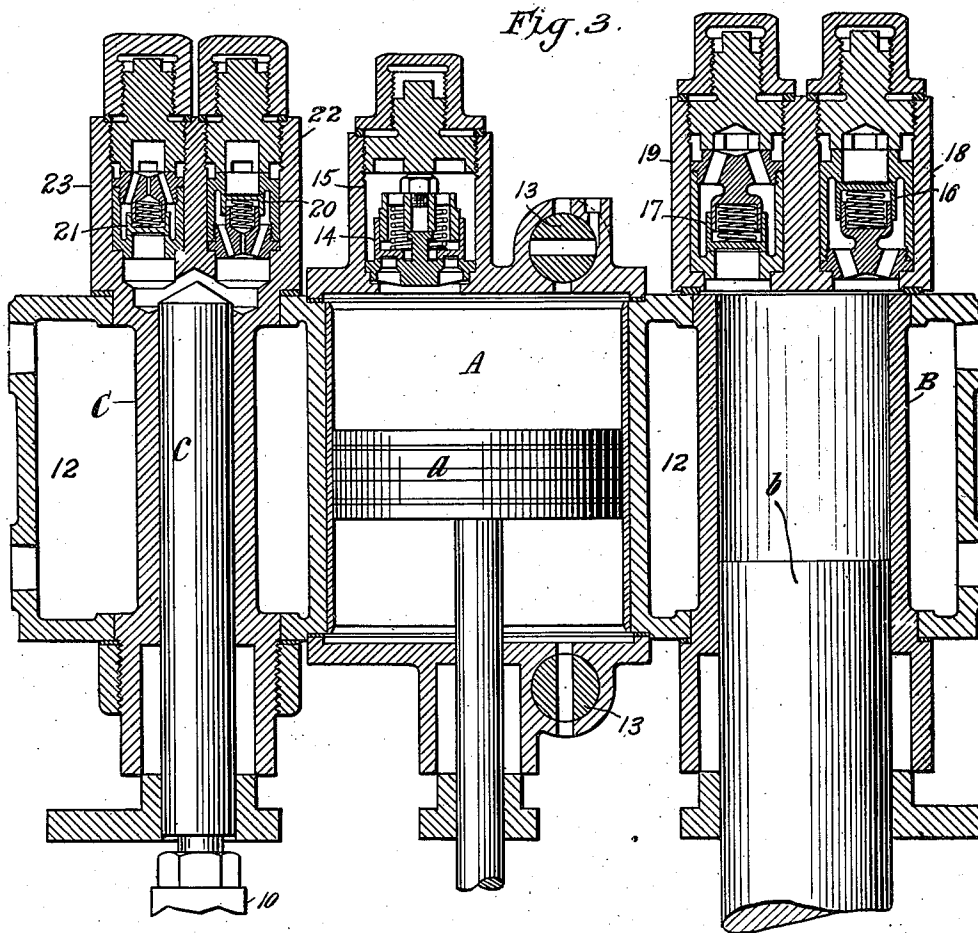
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# UNITED STATES PATENT OFFICE.

MICHAEL RIESNER, OF CINCINNATI, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO WORTHINGTON PUMP AND MACHINERY CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF VIRGINIA.

## AIR-COMPRESSOR.

1,185,942.

Specification of Letters Patent.

Patented June 6, 1916.

Application filed March 4, 1915. Serial No. 11,950.

*To all whom it may concern:*

Be it known that I, MICHAEL RIESNER, a citizen of the United States, residing at Cincinnati, county of Hamilton, and State of Ohio, have invented certain new and useful Improvements in Air-Compressors, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to an improved compressor for air and gases, the special object being to provide a three stage air compressor of simple and compact design, in which the maximum bending moment upon the crank shaft in either direction shall be reduced, and in which the torque shall be more uniform, than in previous three stage compressors, and negative torque be avoided.

The invention includes broadly the combination of a double acting first stage or low pressure cylinder with single acting second and third stage cylinders, arranged on opposite sides of the first stage cylinder, so that the plunger loads are divided between the outward and inward strokes, and thus the maximum load in one direction reduced, with consequent great reduction in the maximum bending moment on the common crank shaft.

The invention includes also a special arrangement of the second and third stage cranks relatively to each other and to the first stage crank, by which the torque is made more uniform than with the usual arrangement of three cranks at 120° apart, and negative torque avoided, so that a smoother action of the compressor is secured, and there is no tendency to backlash on the gears during the entire cycle.

For a full understanding of the invention, a detailed description of a construction embodying the same will now be given in connection with the accompanying drawing, forming part of this specification, and illustrating a preferred embodiment of the invention, and the features forming the invention then specifically pointed out in the claims.

In the drawing, Figure 1 is an elevation of the compressor longitudinally of the crank shaft. Fig. 2 is a sectional end elevation looking to the left in Fig. 1. Fig. 3 is a vertical section through the cylinders looking in the same direction as Fig. 1. Fig. 4 is a diagram showing the torque or crank

effort curves of the three cylinders in dotted lines, and the combined torque or crank effort curve in full lines.

Referring to the drawings: A is the double acting first stage or low pressure cylinder, B, the second stage or intermediate cylinder, C, the third stage or high pressure cylinder, and *a, b, c*, the respective plungers, which plungers are connected to the crank shaft S by cross-heads 10, connecting rods 11, and the cranks *d, e, f*, corresponding respectively, to the plungers *a, b, c*. The cylinders are shown as provided, as usual, with water jackets 12, supplied in any suitable manner.

Any suitable valve movement and arrangement of piping and receivers may be used for the proper supply and discharge of fluid through the series of compressors. As shown, the low pressure cylinder is provided with rotating inlet valves 13, which may be actuated from the crank shaft in any suitable manner, but automatic or other valves may be used. Automatic discharge valves 14 in discharge chambers 15, are shown. The second stage cylinder is shown as provided with automatic suction and discharge valves 16, 17 in suction and discharge chambers 18, 19, on the head of the cylinder, and the third stage cylinders as provided with similar suction and discharge valves 20, 21 on head suction and discharge chambers 22, 23. The low pressure cylinder takes its suction air directly from the atmosphere through valves 13, and the air is discharged from discharge chambers 15 through pipes 24, which connect through pipe 25 with a suitable receiver (not shown), from which air is supplied to the second stage cylinder through pipe 26, and the second stage cylinder delivers through pipe 27 to a suitable receiver (not shown), from which air is supplied to the third stage cylinder through pipe 28, and the air finally delivered from the third stage cylinder through pipe 29.

In Fig. 4 is shown a diagram giving the torque or crank effort curves in pounds throughout a rotation, for each of the three stage pistons and the combined curve. In this drawing the curve of the first stage is shown in dotted lines, the second and third stages in dot and dash lines, and the combined curve in full lines.

Referring now to the arrangement of cylinders and crank shafts, the first stage or

low pressure cylinder A is arranged in the center, with the second stage and third stage cylinders on opposite sides, so that the load of the first stage plunger is carried centrally of the crank shaft, and the loads of the second stage and third stage plungers at the ends of the crank shaft near the end bearings, so that the load of the first stage plunger acts to reduce the maximum load in either direction produced on the crank shaft by the second and third stage plungers and the maximum bending moment on the crank shaft is thus greatly reduced. This arrangement is important in reducing the size and weight of crank shaft required, and securing a smooth action of the compressor, and, as shown, it makes possible the use of a crank shaft with only the two end bearings, reducing the length of the crank shaft and dimensions of the compressor in this direction. This result of smooth action of the compressor is greatly aided also, and a more uniform torque and the absence of negative torque secured, by the arrangement of cranks shown, in which the second and third stage cranks are arranged at an angle of  $180^\circ$  from each other, and the low pressure crank is arranged at  $90^\circ$  from the other two cranks. The result is the torque or crank effort curves shown by the diagram, Fig. 4, in which it will be seen that the combined torque or crank effort curve of the three plungers, shown in full lines, is never below zero, so that there is always a positive forward pressure on the gears during the entire cycle.

It will be understood that the invention is not limited to the particular construction or arrangement of parts in the compressor illustrated as embodying the invention, but that these may be changed widely without

departing from the invention as defined by the claims.

What I claim is:

1. A three stage air compressor having a central double acting first stage cylinder, single acting second stage and third stage cylinders arranged on opposite sides of the first stage cylinder, a crank shaft common to the three cylinders, and separate cranks on the crank shaft for the plungers of the three cylinders.

2. A three stage air compressor having a central double acting first stage cylinder, single acting second stage and third stage cylinders arranged on opposite sides of the first stage cylinder, a crank shaft common to the three cylinders, and separate cranks on the crank shaft for the plungers of the three cylinders, the cranks for the plungers of the second stage and third stage cylinders being arranged  $180^\circ$  apart, and the crank for the plunger of the first stage cylinder  $90^\circ$  from the other two cranks.

3. A three stage air compressor having a double acting first stage cylinder, single acting second stage and third stage cylinders, a crank shaft common to the three cylinders, and separate cranks on the crank shaft for the plungers of the three cylinders, the cranks for the plungers of the second stage and third stage cylinders being arranged  $180^\circ$  apart, and the crank for the plunger of the first stage cylinder  $90^\circ$  from the other two cranks.

In testimony whereof, I have hereunto set my hand, in the presence of two subscribing witnesses.

MICHAEL RIESNER.

Witnesses:

ANNE O. WERNER,  
CARL G. WERNER.