

PATENT SPECIFICATION

179,959

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COMPLETE SPECIFICATION.

Improvements in Internal Combustion Engines.

We, JEAN JOSEPH MARIE BERTRAND, of 71, rue Michel-Ange, and LOUIS JOSEPH HENRY SOLANET, of 3, rue de la Muette, both of Paris, France, French citizens, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

10 This invention relates to four stroke explosion engines or internal combustion engines with $4p$ cylinders (p being a number greater than 1); it consists substantially in the combination of p elementary four cylinder engines of known type in each of which the four cylinders are placed in two opposite lines and have all their axes parallel to a single direction. In this engine, the cranks of each group of four cylinders are in the same plane and the various radial planes of the cranks of the groups of four cylinders are equally displaced relatively to one another.

Individually, each of these four cylinder engines is unbalanced, but the combination of engines so obtained is balanced and gives numerous advantages as will be hereinafter explained.

Two known types of four cylinder engine can be used as an element in the said combination and give two types of engines which lie within the scope of the present invention.

35 According to the first type, an engine with $4p$ cylinders is made by means of p elementary four cylinder engines in each of which the piston-rods of two opposed cylinders act on the crank shaft at two diametrically opposed points and, therefore, in each of which the crank shaft has the known form with four or three cranks. Then, the elementary crank shafts are angularly displaced one
45 to another by $\frac{180^\circ}{p}$ when p is even and $\frac{180^\circ}{p}$ or $\frac{360^\circ}{p}$ when p is odd.

~~[Redacted]~~

According to the second type, an engine with $4p$ cylinders is made by means of an odd number ($p=2m+1$; m being a number greater than zero) of elementary four cylinder engines in each of which the two connected opposed cylinders act on the crank shaft at the same point, and, therefore, in each of which the crank shaft has the known form with two cranks. Then, these various crank shafts are angularly displaced one to another by $\frac{180^\circ}{p}$.

These engines of both types give numerous advantages and particularly with regard to the facility of the feeding of the cylinders, the simplicity of construction of the engine and the perfection of the balancing, and the said advantages are not simultaneously obtained in the engines at present used with six or more cylinders arranged in two opposite lines or in the known engines of the same power with four cylinders only or in the known engines with $4p$ ($p=2m+1$) cylinders arranged in various radial lines.

In addition to the various advantages already obtained in some types of engines, *i.e.*, the possibility of using one carburettor only for each group of four cylinders, the simplicity of the piping, the regularity of the crank turning moment, the present invention gives particular advantages, namely:

1. The possibility of making the crank shaft by means of p parts in each of which all the cranks are arranged in the same plane, the said parts being identical, placed end to end and suitably angularly displaced relatively to one another,

2. The possibility of reducing to $p-1$ only for $4p$ cylinders the number of intermediate supporting brackets, that is to say one bracket only between two elementary groups of four cylinders, all the intermediate brackets being taken off in

each elementary group of four cylinders, and the possibility of using ball or roller bearings,

3. As a consequence of this simplification of the crank shaft, increased facility of fitting the ball or roller bearings,

4. The obtaining of the balancing by making but little call on the rigidity of the engine bed, and, therefore, the possibility of making the said engine bed lighter than the ones at present used, because by reducing the linear displacement l (Fig. 2), the inertia couples which are mutually balanced are also reduced.

5. The perfection of the balancing gives the possibility of running the motor at higher speeds than ordinary motors, which allows of the construction of lighter motors than the ones at present used.

Besides, in the engine of the second type, the centre of gravity of the moving parts is stationary and the harmonics of any order are rigorously balanced.

The above advantages allow of using in any motor vehicle or aeroplane the engines with $4p$ cylinders arranged in two opposite lines. As such an engine requires only a small place it is possible to arrange it beneath the body of the vehicle and consequently at any part of the length of the vehicle; in the aeroplanes, it is possible to arrange such an engine of great power in wings of a relatively small thickness.

The following tables sum up the explanation of the characteristics of the most used motors which can be constructed according to the present invention.

I.—FIRST TYPE.

Number of cylinders	Number of crank pins	Number of groups of four cylinder engines with plane three or four throw crank shafts.
8	6 or 8	2
12	9 or 12	3
16	12 or 16	4
20	15 or 20	5

II.—SECOND TYPE.

Number of cylinders	Number of crank pins	Number of groups of four cylinder engines with plane two-throw crank shafts
12	6	3
20	10	5
28	14	7

In the accompanying drawings given by way of example and acting as illustrations only of the present invention:

Figs. 1 to 13 refer to the motors of the first type.

Figs. 14 to 17 to the motors of the second type.

Figs. 1 and 2 show a known type of engine having four cylinders arranged in two opposite lines and a plane four-throw crank shaft.

Figs. 3 and 4, an eight cylinder engine having five bearings and eight crank pins with the crank shaft made of two plane four-throw crank shafts.

Figs. 5 and 6 another eight cylinder engine having three bearings and six crank pins with the crank shaft made of two plane three-throw crank shafts.

Fig. 7 another eight cylinder engine similar to the engine of Figs. 5 and 6, having a crank shaft made of two plane three-throw crank shafts displaced relatively to one another by 90° according to the arrangement of the Fig. 5, the said eight cylinder engine having as shewn in Fig. 6, seven bearings instead of three.

Figs. 8 and 9 a twelve cylinder engine having seven bearings, twelve crank pins and a crank shaft made of three plane four-throw crank shafts.

Figs. 10 to 13 have reference to a twelve cylinder engine and show side by side the two types of the crank shaft when p is odd (in a twelve cylinder motor $p=3$); the Figs. 10 and 11 show a crank shaft having three plane parts displaced

relatively to one another by the angle

$$1^a 1^b = \frac{360^\circ}{p} = 120^\circ \text{ and the Figures 12}$$

and 13 show a crank shaft in which the plane parts are displaced relatively one

5 to another by the angle $1^a 1^b = \frac{180^\circ}{p} = 60^\circ$.

According to the invention, the crank shafts of the above engines are made in several plane parts with three- or four-throw crank shafts assembled together

10 end to end and angularly displaced relatively one to another as shown in the accompanying drawings.

Figs. 14 and 15 show the known elementary type of engine having four cylinders arranged in two opposite lines and a plane two throw crank shaft.

Figs. 16 and 17 a twelve cylinder engine having four bearings and six cranks, the said engine being fitted with three plane two-throw crank shafts. These three parts are assembled relatively one to another as shown in the drawings.

Besides, in each of the said engines, in each group of four cylinders, the adjacent cylinders can be put close in order to reduce the linear displacement l and the distance between the bearings p p^1 can be as small as possible.

In each group of four cylinders shown in the drawings, the cylinders and the corresponding parts of each cylinder are indicated with the numbers 1, 2, 3 or 4 together with a letter $a, b, c, etc.$ in order to distinguish at once the various groups of four cylinders and so to make instantaneous the understanding of the said drawings and motors.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. An internal combustion engine comprising a plurality of groups of four cylinders and having the $4p$ cylinders of the engine arranged in two opposed lines with their axes parallel, in which

the crank shaft of each group of four cylinders lies in a single plane and all the cranks of the various groups of four cylinders are identical and arranged in p planes displaced equally relatively to one another. 50

2. An internal combustion engine as claimed in Claim 1 in which the rods of the pistons of two opposed connected cylinders act on the crank shaft at two diametrically opposite points, the various identical parts of the crank shaft of the engine being displaced relatively to one another by $180^\circ/p$. 55 60

3. An internal combustion engine as claimed in Claim 1 in which the rods of the pistons of two opposed connected cylinders act on the crank shaft at two diametrically opposite points, the various identical parts of the crank shaft of the engine being displaced relatively to one another by $360^\circ/p$. 65

4. An internal combustion engine as claimed in Claim 1 in which the number p of the groups of four cylinders is odd and in which the crank shaft of each group of four cylinders is provided with two cranks only, the rods of the pistons of the two opposed connected cylinders acting on the said elementary crank shaft of the group at the same point, the various sections of the crank shaft of the engine being displaced relatively one to another by $360^\circ/p$. 70 75 80

5. An internal combustion engine as claimed in Claim 1 in which the crank shaft is provided composed of p identical plane sections placed end to end and displaced equally relatively to one another. 85

6. A four stroke internal combustion engine constructed and arranged to operate substantially as described with reference to Figs. 3—13, 16 and 17 of the accompanying diagrammatic drawings. 90 95

Dated this 12th day of May, 1922.

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Chartered & Registered Patent Agents,
12, Church Street, Liverpool.

FIG. 1.

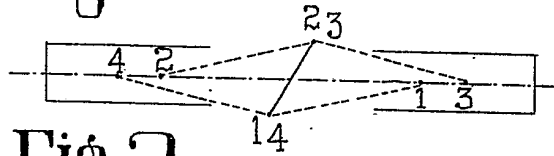


FIG. 2.

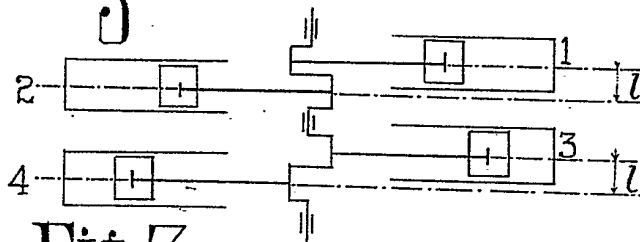


FIG. 3.

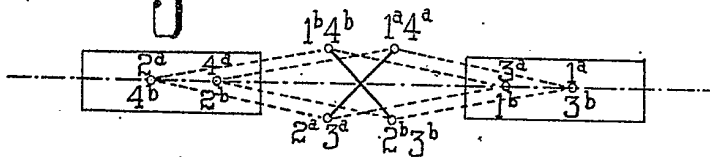
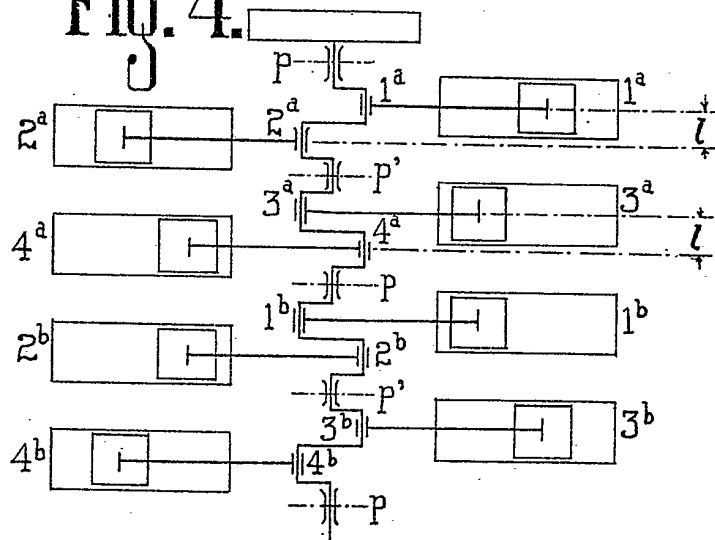


FIG. 4.



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Fig. 5.

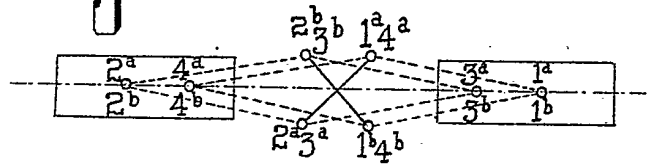


Fig. 6.

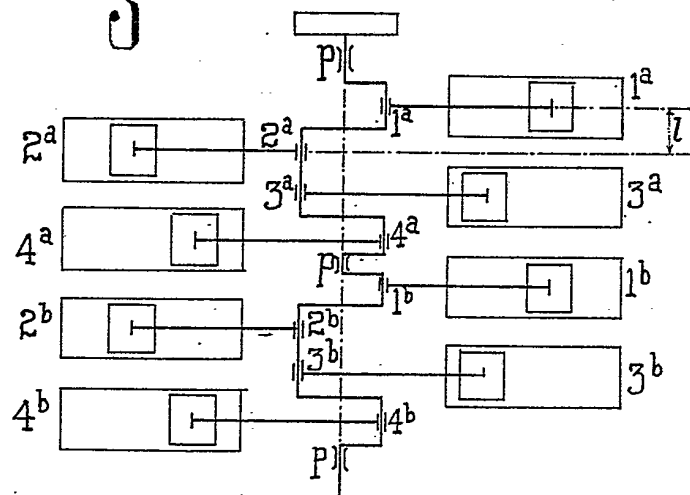


Fig. 7.

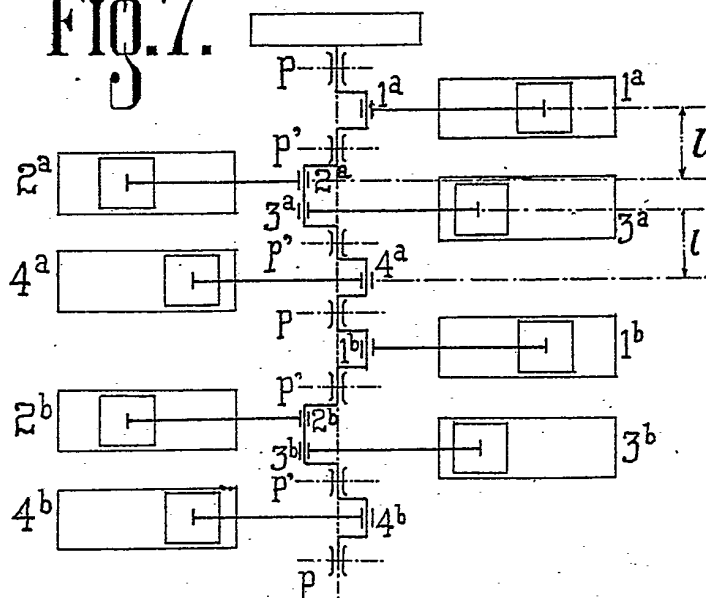


FIG. 1.

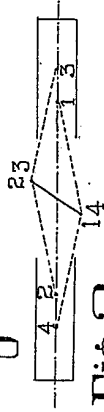


FIG. 2.

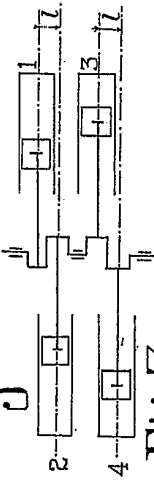


FIG. 3.



FIG. 4.

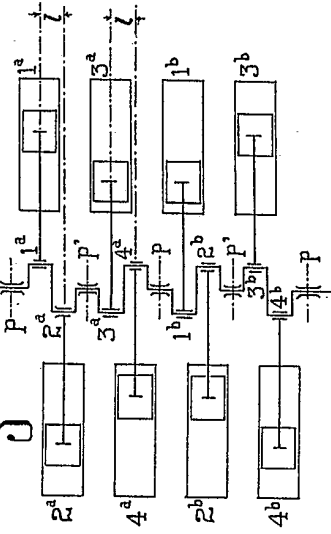


FIG. 5.



FIG. 6.

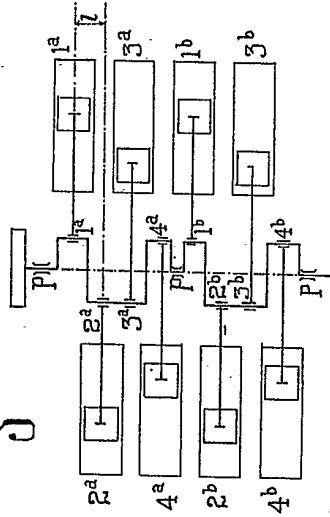
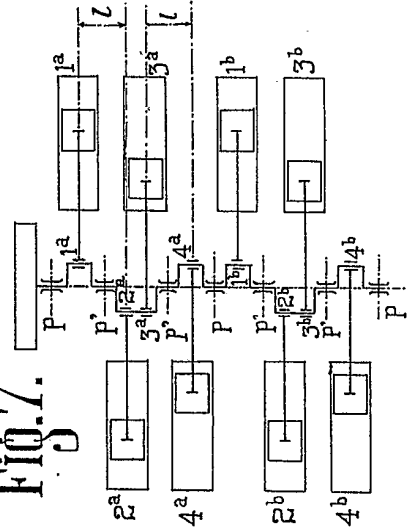


FIG. 7.



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Fig. 8

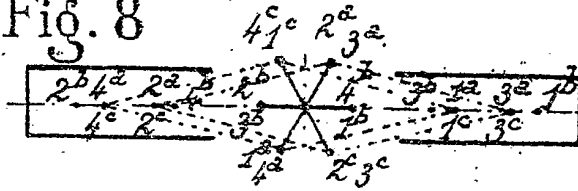
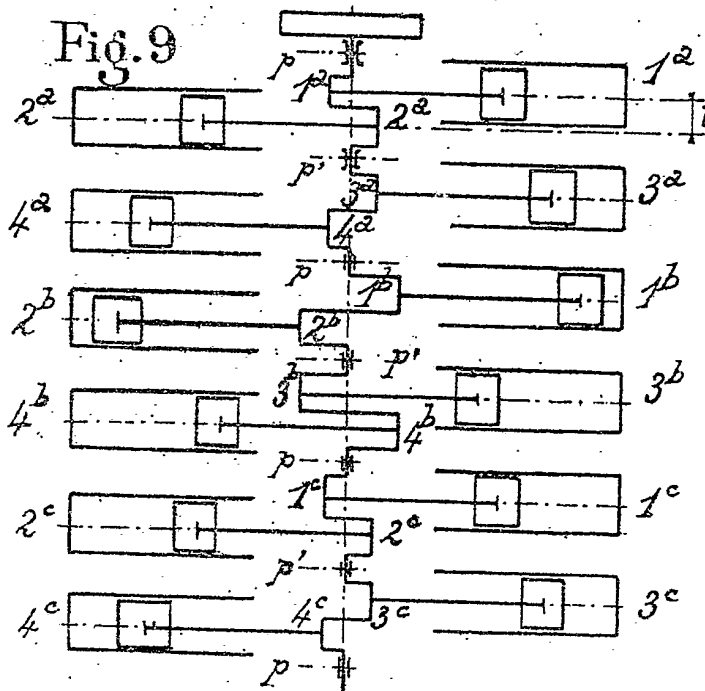


Fig. 9



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Fig. 10

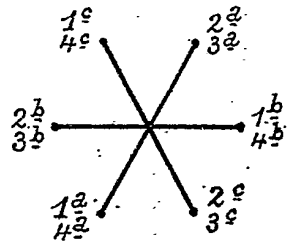


Fig. 12

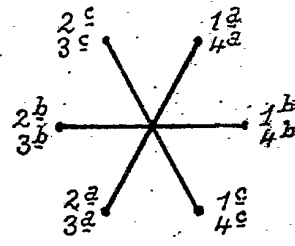


Fig. 11

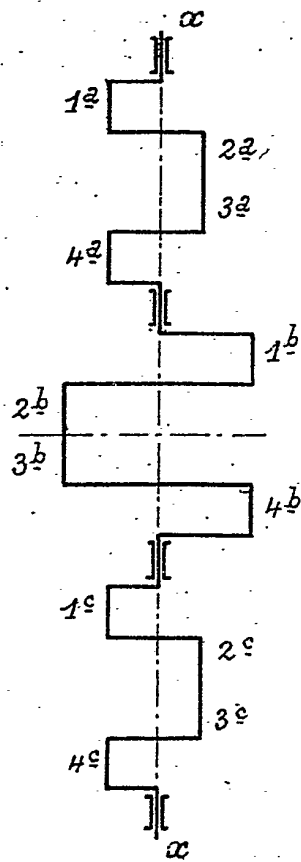


Fig. 13

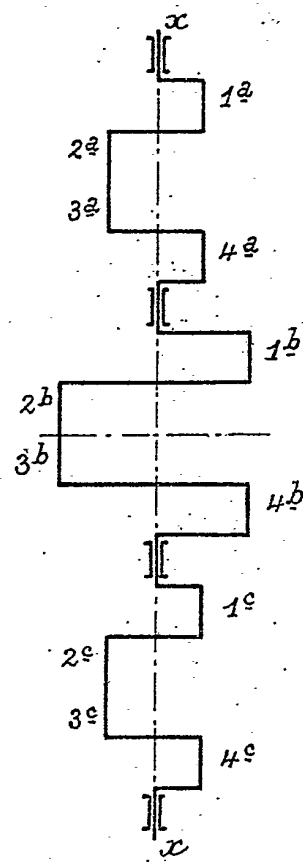


Fig. 8



Fig. 10

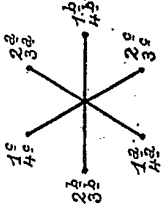


Fig. 12

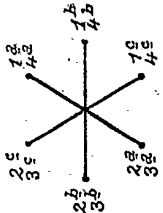


Fig. 9

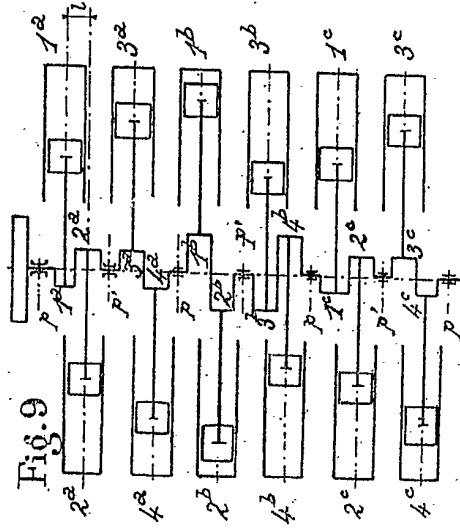


Fig. 11

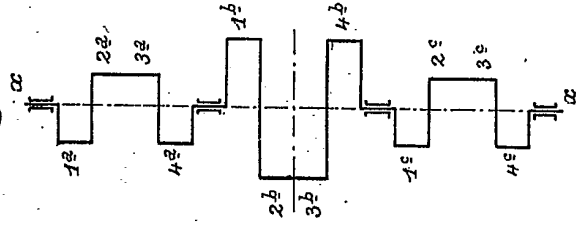
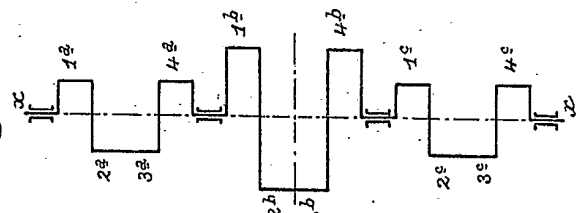


Fig. 13



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FIG. 14.

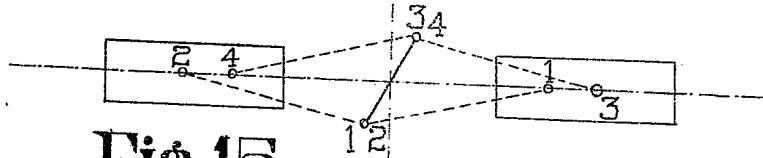


FIG. 15.

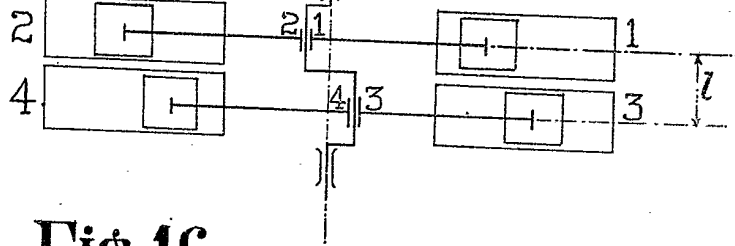


FIG. 16.

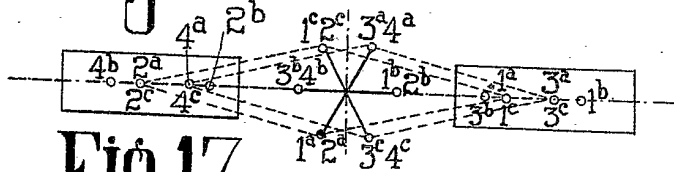
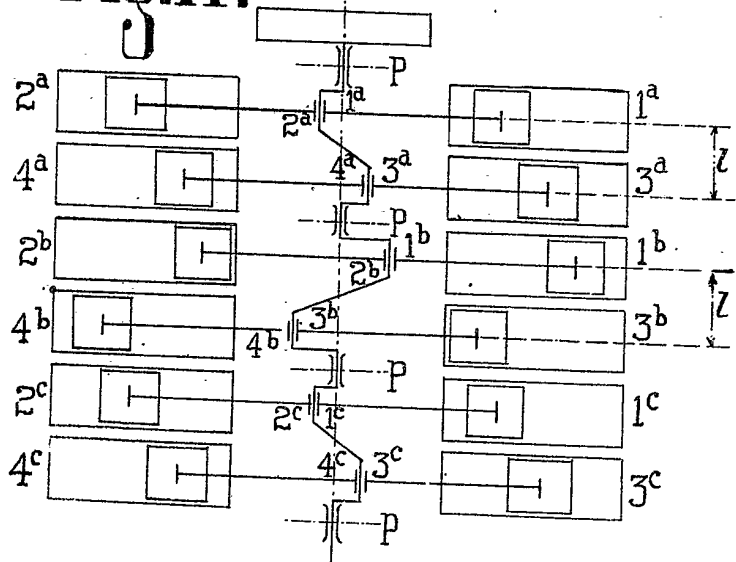


FIG. 17.



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