No. 778,542. PATENTED DEC. 27, 1904.

A. C. KREBS.

SYSTEM OF EQUILIBRIUM FOR MOTORS.

APPLICATION FILED AUG. 9, 1901.

Fig. 1.

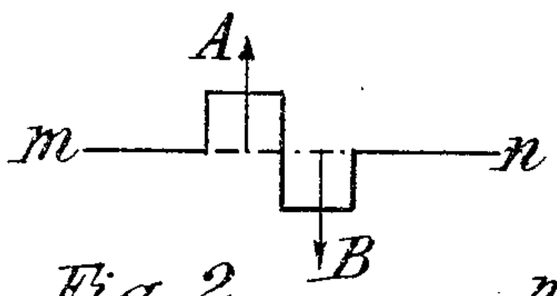


Fig. 2.

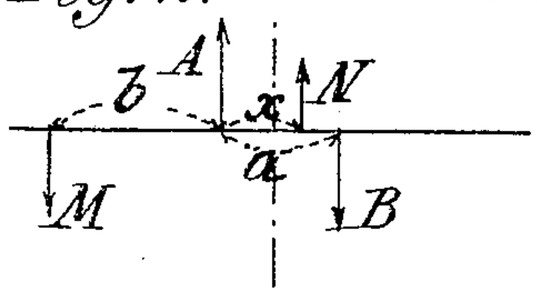


Fig. 5.

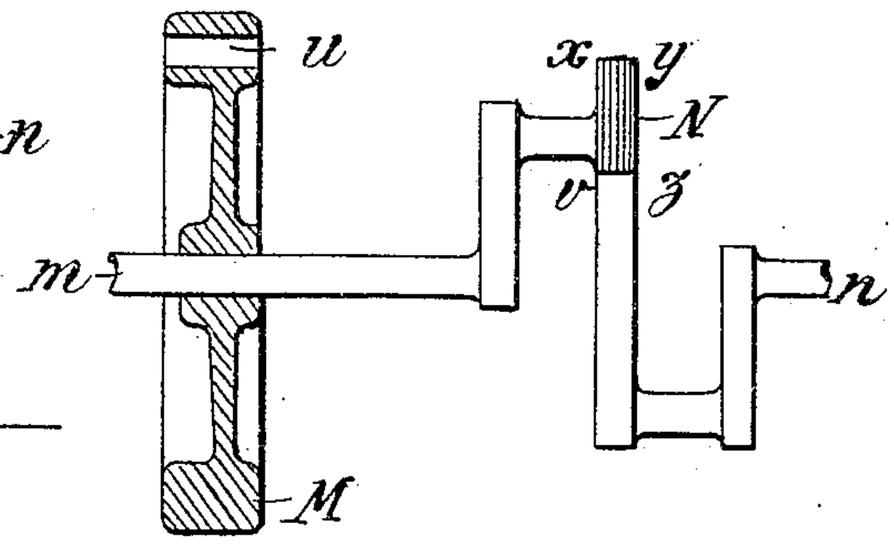


Fig. 3.

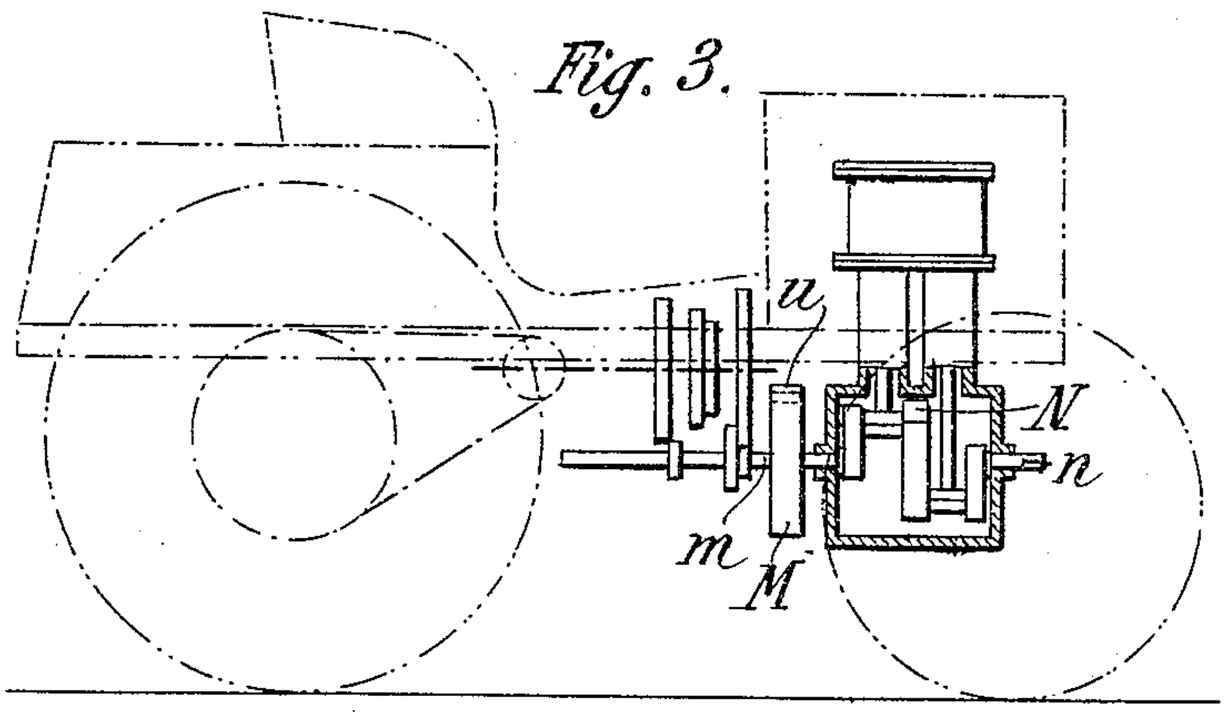
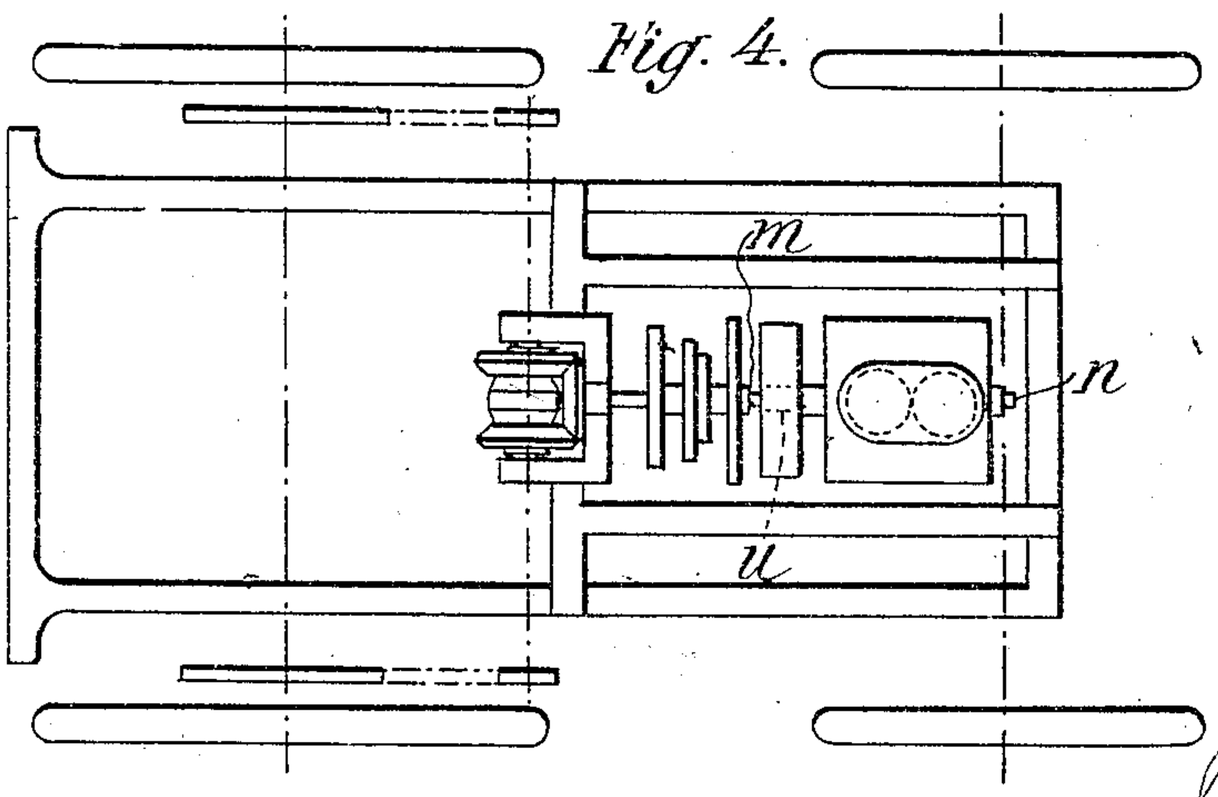


Fig. 4.



Witnesses.
Thomas F. Wallace
René Bruine

Inventor:
Arthur Constantin Krebs,
By his Attorneys,
Arthur G. Fraser & Co.

No. 778,542. Patented December 27, 1904.

UNITED STATES PATENT OFFICE.

ARTHUR CONSTANTIN KREBS, OF PARIS, FRANCE, ASSIGNOR TO STÉ. AME. DES ANCIENS ETABLISSEMENTS PANHARD ET LEVASSOR, OF PARIS, FRANCE.

SYSTEM OF EQUILIBRIUM FOR MOTORS.

SPECIFICATION forming part of Letters Patent No. 778,542, dated December 27, 1904.

Application filed August 9, 1901. Serial No. 71,516.

To all whom it may concern:

Be it known that I, ARTHUR CONSTANTIN KREBS, a citizen of the Republic of France, residing in Paris, France, have invented certain new and useful Improvements in Systems of Equilibrium for Motors Having Two Cylinders, of which the following is a specification.

The object of this application for patent is to effect equilibrium of motors having two cylinders, based upon the following general considerations.

In a motor having reciprocating pistons the moving masses may be resolved into two—first, the masses moving to and fro in straight lines; second, the masses that rotate. The former masses cannot be absolutely balanced, except on condition of obtaining moments of force and direction, such that the resisting couple, which they cause at each instant, shall be *nil* in two perpendicular planes. This cannot be realized by the pistons alone if they have speeds in the same direction—that is to say, connected to the same crank. I shall therefore consider only the case of the two pistons connected to opposite cranks.

When the pistons are connected to opposite cranks, the balancing of the reciprocating parts is possible in whole or in part. The disturbing moment situated in the plane of the axis of the motor and of the pistons tends to produce in this plane an oscillating movement of the whole mass around an axis perpendicular to this plane. This movement is the less powerful the nearer the pistons are to one another, the lighter they are, and the greater the masses are which partake of the oscillating movement and the greater the length over which they extend—that is to say, the farther from the axis of oscillation. In order to attain this result, the motor has to be so arranged as to cause the whole of its mass and as much as possible of the mass of its support to partake of the oscillatory movement. The position of the motor, the axis of which is situated in the longitudinal vertical plane of a vehicle or boat, for instance, insures this condition, and practically the disturbing couple is annulled by the resisting moment of the vehicle or boat.

I have devised the following system of absolutely balancing the masses having rotary movements: Assuming that, as shown in Figure 1, two cranks set opposite to one another on the shaft $m\,n$, these cranks and the parts of the connecting-rods which partake of the rotary motion produce two moments A and B, forming a couple turning around $m\,n$. By the action of the couple one tends to describe a conical movement, the apex of the cone being on the axis at a point which varies with the position of the masses on the shaft.

The effect of the couple A B may be annulled as follows: They may be taken to be equal. Let other two moments M and N be produced, as shown in Fig. 2, also equal and such that the resultant of A and N is equal and opposite to the resultant of B and M. We have then

$$M(b+a)=Aa+N(a-x),$$

$Mb+Ma=Aa+Na-Nx$ or, finally, as $M=N$,

$$Mx=Aa-Mb.$$

Of the four variables M x a b three, (as x, a, and b) may be given by determining them, according to the condition of the construction, and the fourth can be deduced. Putting the equation in the form $M=\frac{Aa}{x+b}$, it is seen that M may vary between O and infinity, according to the values assumed for x and b—that is to say, according to the positions which it may be possible or desirable to give to the additional masses.

In the following example let a be the distance between the axes of the pistons and b the distance of the fly-wheel M from its nearest piston. Assuming $x=\frac{a}{2}$, that is to say,

that the balancing-weight N is half-way between the pistons, then

$$M\frac{a}{2}=Aa-Mb,$$

$$M(a+2b)=2Aa,$$

$$M=\frac{2A}{2\frac{b}{a}+1}.$$

Putting $\frac{b}{a}=K$, then

$$M=\frac{2A}{2K+1}.$$

The relations of the moments M and A to each other are therefore known, and their masses can be deduced, according to their distances from the axis of the motor.

The accompanying drawings show by way of example the application of my system of balancing to a vehicle shown in elevation in Fig. 3 and in plan, Fig. 4. Fig. 5 is a separate detail showing how the masses M and N may be placed or fixed. The mass N is placed on the crank at *v x y z* and the mass M on the fly-wheel. It may, for instance, be the result of a hollow *u*, formed opposite to where the mass M is required.

Having thus described the nature of this invention and the best means I know for carrying the same into practical effect, I claim—

1. In a two-cylinder motor, means for equilibrating the disturbing couple created by the reciprocation of the masses of the pistons and their rods, which consists of a fly-wheel unsymmetrically proportioned, and a counterweight upon the crank, the fly-wheel and the counterweight being arranged and proportioned to produce a couple which equilibrates said disturbing couple.

2. In a two-cylinder motor, means for equilibrating the disturbing couple created by the reciprocation of the masses of the pistons and their rods, which consists of a fly-wheel having a hollow formed on one side thereof whereby to throw an excess of weight to the other side, and a counterweight on the crank-arm which unites the two crank-pins of the shaft, such parts being arranged and proportioned to produce a couple which equilibrates said disturbing couple.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

ARTHUR CONSTANTIN KREBS.

Witnesses:
JULES ARMENGAUD, Jeune,
MARCEL ARMENGAUD, Jeune.