

July 9, 1929.

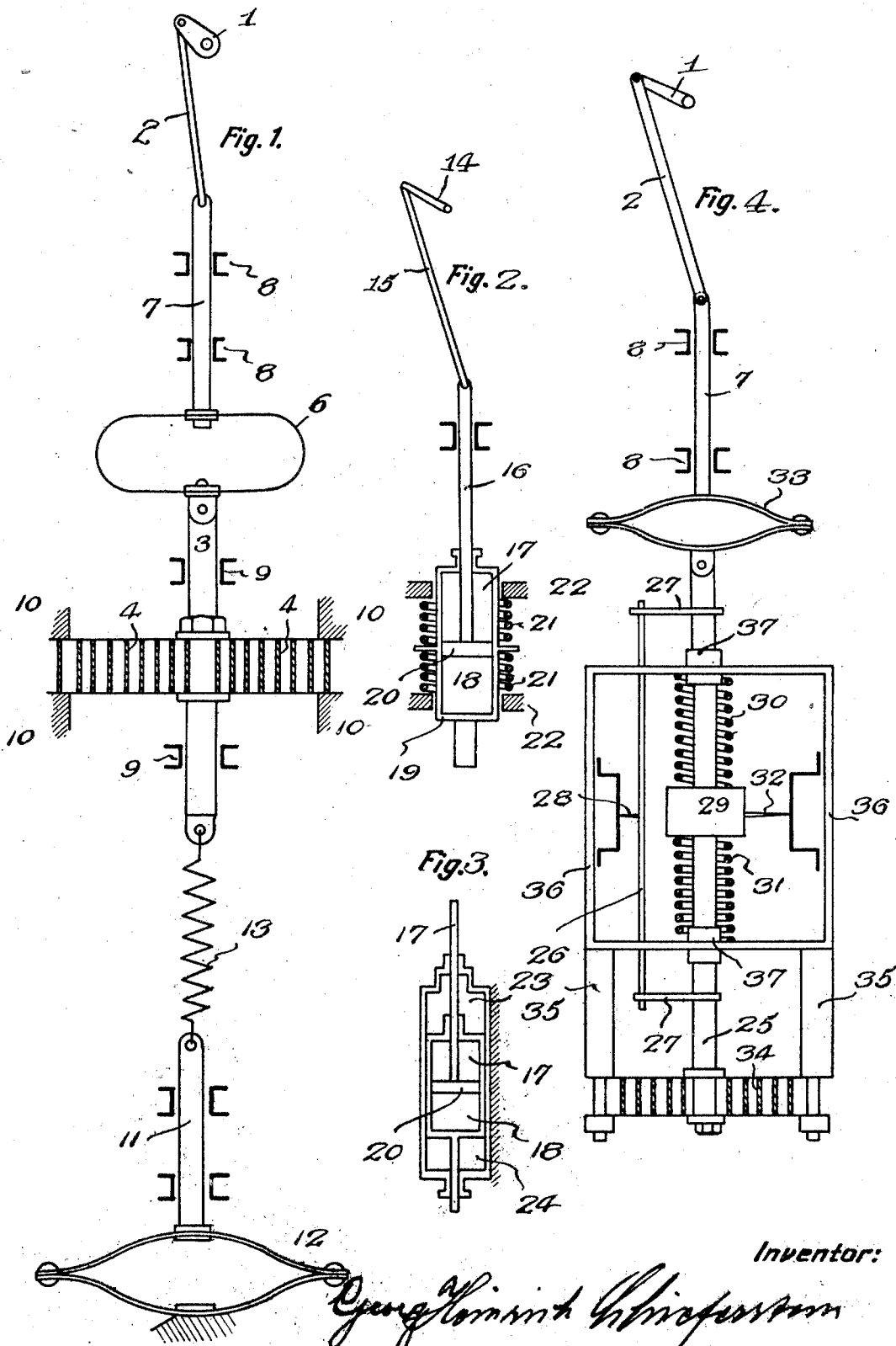
G. H. SCHIEFERSTEIN

1,720,574

POWER TRANSMITTING MEANS BY OSCILLATORY MOVEMENTS

Filed July 18, 1922

2 Sheets-Sheet 1



Inventor:

G. H. Schieferstein

July 9, 1929.

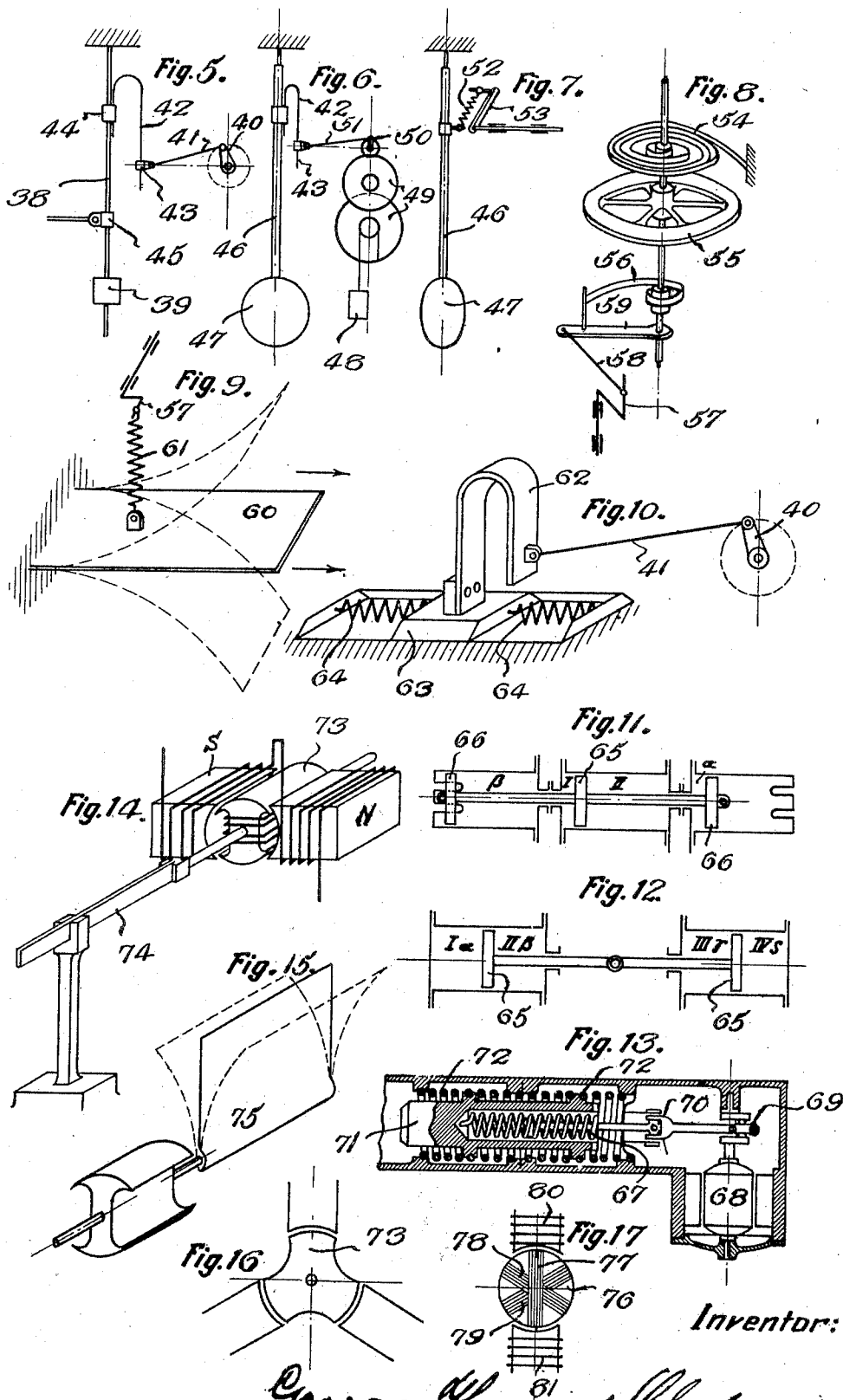
G. H. SCHIEFERSTEIN

1,720,574

POWER TRANSMITTING MEANS BY OSCILLATORY MOVEMENTS

Filed July 18, 1922

2 Sheets-Sheet 2



Inventor:

Georg Heinrich Schieferstein

UNITED STATES PATENT OFFICE.

GEORG HEINRICH SCHIEFERSTEIN, OF BERLIN-CHARLOTTENBURG, GERMANY.

POWER-TRANSMITTING MEANS BY OSCILLATORY MOVEMENTS.

Application filed July 18, 1922, Serial No. 575,894, and in Germany November 10, 1921.

My invention relates to the method and means for imparting to an oscillatory system mechanical energy from an oscillating or reciprocating system, said energy being exerted by positive impulses substantially in synchronism with the first mentioned system.

Freely oscillating systems cannot be directly driven because the customary driving elements vary in amplitude from zero to a maximum and out of tune with the natural oscillation of the system to be driven, and in order to do this efficiently I provide an elastic or resilient connection between the driven and driving elements operating substantially in synchronism.

The mechanism comprises essentially an exciting or driving element; an excited or driven element, and resilient or elastic means between the elements and through which the driving impulses are transmitted from one to the other in substantial synchronism to the periodicity of the driven element.

This elastic or resilient means, acting as a yielding coupling, may be termed a loose coupling, and may consist of a spring, a magnetic field, an air cushion, etc., as will more fully appear hereinafter with respect to the specific constructions illustrated.

Figure 1 is one type of oscillating system, reciprocable.

Fig. 2 is another form in which air cushions on opposite sides of a piston transmit the movements of a crank to the reciprocating, spring-supported cylinder.

Fig. 3 is a form illustrating the use of gas cushions.

Fig. 4 is a form from which the relative efficiency of two systems may be ascertained.

Fig. 5 shows a construction for driving a reciprocable element from a crank drive through an oscillating member.

Fig. 6 is a clock mechanism employing the principles of my invention.

Fig. 7 shows another form of pendulum operation.

Fig. 8 shows a balance wheel mechanism.

Fig. 9 shows the manner of operating a flexible blade.

Fig. 10 shows the manner of operating a reciprocating cross head.

Fig. 11 shows a steam engine and connected cushioning pistons.

Fig. 12 represents an explosion engine.

Fig. 13 illustrates the application of the invention to a percussion tool.

Fig. 14 shows an electric armature mounted upon a spring.

Fig. 15 illustrates an electrical and mechanical oscillating system combined.

Fig. 16 illustrates a three phase oscillating armature mounted upon a torsional axle.

Fig. 17 illustrates a repulsion motor whose armature is made to oscillate in accordance with this invention.

In Figure 1 I have shown a rotating crank 1 and a connecting rod 2 which together form the exciting system which is reciprocating in its operation.

The excited system is the mass 3 and spring 4 which together have a specific periodicity, and freely oscillate. The two systems are connected by a yielding or resilient coupling, so-called loose coupling, and constituted by the spring 6.

Upon the crank 1 being rotated the rod 7 is caused to move to and fro in a path whose length is determined by the eccentricity of the crank 1 and flexure is produced in one direction or the other in spring 6. The tension in spring 6 is transferred to oscillating system 3, 4, which at small numbers of rotation of crank 1 is moved but small distances from its middle position in opposite directions, but upon increasing the speed of the crank the amplitude of movement of the oscillating system 3, 4, will increase and the greatest amplitude will be attained when the number of revolutions of the crank reaches the frequency of natural oscillation of the system, i. e., resonance or synchronism. If the number of revolutions of the crank exceed this the amplitude of the system will suddenly decrease to approximately zero.

It will thus be seen that by inserting a resilient or elastic member such as 6 between a crank mechanism and an oscillatory system, the latter can be excited to oscillate freely and the maximum effect will be attained if the number of revolutions of the crank is tuned to the natural frequency of the oscillatory system. The resilient member 6 is the "loose coupling" and compensates for differences in amplitude between the crank and system and at the same time transmits to the system the energy temporarily consumed by damping. Such a coupling is ca-

pable of continuously transferring energy to an oscillatory system and will accommodate itself automatically to varying amplitude of the system.

The less the effect transmitted the looser will the coupling act, and the greater the effect transmitted the closer will be the coupling, i. e. approaching a rigid connection. The rod 7 is guided in bearings 8 and the rod 3 in bearings 9, while the spring 4 is supported at 10.

The amplitude of the system is entirely dependent upon the damping of the system, and if the damping decreases, the amplitude increases but the energy transmitted by the coupling will not be altered.

The foregoing is true if several oscillating systems are connected together, as for example in Fig. 1 where a second system 11, 12 is connected to the system above it by a spring 13.

Fig. 2 shows, by way of example, a construction when air cushions 17 and 18 are used as the elastic means or coupling between the exciting system 14, 15, 16, and piston 20, operating on the excited system comprising a cylinder 19 supported by springs 21 between stationary supports 22.

In Fig. 3 both systems use air cushions, wherein the cushions 17, 18 pertain to the exciting system and the cushions 23 and 24 to the excited system.

In Fig. 4 is shown another form of an oscillating system of the kind described, provided with means for measuring the output or efficiency. To the movable part on rod 25 is secured a light bar 26 by means of two arms 27 that is provided with a recording stylus 28. Inasmuch as the bar 26 shares the movement of the rod 25, the deflection may be recorded each time upon a strip of paper travelling over a paper support past the point 28. A brake block 29 is secured to the rod 25, which is retained between two coil springs 30 and 31, and is so arranged as to be tightened more or less to the shaft. Upon moving the rod 25 in one direction the brake block 29 is carried along until the increasing tension of one of the springs 30 or 31 overcomes the friction on the rod 25 and causes the brake block to slip. From the force with which the springs 30, 31 are compressed up to the slipping point, and the path of movement of the brake block upon the rod 25, the force may be calculated. The values of both elements are determined from the curve drawn by the recording pin 32 on the brake block 29. The output energy consumed by the braking action, divided by the power supplied, is equal to the degree of efficiency. If on the one hand an elastic oscillating system provided with elastic coupling member is used, and on the other hand, a rigid system is employed, by the removal of the springs 33 and 34 and the insertion of a rigid connection between the members 2

and 25, a comparison may be made between the efficiency factor of one and the other mode of operating by means of the braking dynamometer 29, 30, and 31 of Figure 4. The spring 34 is mounted in frame members 35 that also support a frame 36 provided with bearings 37 in which the rod 25 is mounted.

It is evident that in all those mechanisms which heretofore were kept moving by means of excitation by impact or impulse, such as watches and the like, may also be operated with an elastic coupling, in which case the energy supplied may be adjusted and gauged far more delicately. By this means I am enabled to produce watches with perfectly noiseless operation.

We may also assume that the elastic coupling medium is not enclosed at all in cylinders, but that, for instance, an oscillating plane produces oscillations in the surrounding atmospheric air which are re-transmitted to the surface, and in this manner effect a transmission of energy. The transmission of energy by elastic coupling in accordance with my invention is, therefore, based upon the fact that in the intermediate member connecting the systems, stresses are produced and are conveyed from it. This may take place during oscillating movement as well as during the forward and backward movement separately. In the latter case a kind of valve action would be the result.

Inasmuch as the systems excited in this manner, and shown in Figures 1 to 4 constitute oscillatable structures consisting of elastic means and masses, the transmission of energy follows a resonance curve. That is to say with a number of revolutions commencing with zero the output first rises very slowly, and then gradually increases, so as to reach the maximum value when tuning synchronism is reached, and decreases again beyond synchronism. In the same manner the efficiency co-efficient reaches its maximum value directly before reaching synchronism.

Now, inasmuch as it appears from the above statements that the individual oscillating period of the oscillatable system, and consequently the resonance position and the value of maximum efficiency, may be displaced so as to be positioned at any point of the oscillation scale, the designer constructing such a system is at liberty, in accordance with this invention, to utilize reciprocating movements of any desired number of oscillations with a high degree of efficiency.

In Figures 5 to 17 I have illustrated by way of example mechanisms embodying the principles of my invention in practical operation. In all these figures the fundamental elements are designated with the same reference characters.

In Fig. 5 the oscillating system comprising the pendulum rod 38 and its bob 39 is excited by the crank drive 40, 41 through the

medium of an elastic coupling 42 formed as a flat spring and to which the pitman rod 41 of the crank drive is secured. Such a construction yields work in the form of reciprocating movement. Thus, for instance, the system may be applied to the pitman of a mowing machine or the like. Upon the rotation of the crank 40 the coupling 42 by which the displacement of its fastening members 43 and 44 may be loosened or tightened more or less, may be flexed in the first place. Its oscillations are transmitted to the system 38, 39 which is tuned in phase with the crank drive by displacement of the mass or by other means. A fastening member 45, adjustable along the pendulum rod 38, has pivoted thereto a rod which transmits the desired output from the system, that is to say, it effects the damping of the system by a withdrawal of output. If it is desired to change the damping of the system 38, 39 this effect may be produced by displacing the fastening member, 45.

Figure 6 represents diagrammatically a clock mechanism, some of the parts of which are constructed in accordance with the device hereinbefore described. The oscillating system in this case, however, is formed by a pendulum, that is to say, by a mass 47 oscillating in the field of the earth, the latter in this case taking the place of the elastic medium. For the purpose of maintaining the oscillations, energy is supplied to the pendulum by means of the weight 48, through a train of gearing 49, a crank drive 50, 51 and spring 42. The pendulum in its turn controlling the clock work, reacts in a controlling sense, that is to say it does not permit the crank 50 to make more than one rotation for each oscillation of the pendulum. The gauging of the ratios of energy is effected by the displacement of the fastening members 43 and 44, for the coupling spring 42 that is to say, by a change of coupling.

Figure 7 shows another modification, which is likewise adapted for the control of mechanisms for the measuring of time (clocks, or the like) by means of swinging systems. The pitman rod 41, 51 is omitted, and the elastic coupling in this case is a single element, a coil spring 52 between the crank 53 and the pendulum.

In Figure 8 I have shown a controlling mechanism for clocks and the like in which instead of the pendulum swinging in the field of the earth I use a spring balancing member, that is to say, a swinging system consisting of a collecting spring 54 and an oscillating mass 55. In this case the elastic coupling is a spiral spring 56 which is excited by the crank mechanism 57, 58, 59.

In Figure 9 the crank 57 operates the oscillating flexible surface 60 by means of the elastic coupling 61. If a surface of this kind, which in itself possesses both elasticity as well as mass, is excited with regard to its own

oscillation, it will oscillate in the manner indicated in dotted lines in Fig. 9, and will impart a movement to the surrounding air, which is indicated by arrows in the drawing, and which is sufficiently known by the procedure of fanning. The degree of efficiency of devices of this kind is highly satisfactory provided the elastic blade is not strained beyond its limit of elasticity, so that devices of this kind may be used in all those conditions of operation where heretofore rotating propellers have been used. It, therefore, results that devices of this kind may also be employed as propelling members for sliding boats and ships in water and in the air, and for the driving of sleighs and automobiles and for aviation purposes.

It is obvious that a great variety of forms of execution may be employed; thus, for instance, the elastic coupling 61 instead of containing a spiral spring may be replaced by springs, such as are shown for example in Figs. 1, 4, 5, 6 and 10. Moreover, the oscillating surface may be connected directly with an oscillating or reciprocating member of a motor, which in its turn is elastically coupled to a source of energy, and as such I may use, for example, the armature of an electric motor, Figure 15, or the piston of an explosion engine, Figures 11 and 12.

In Figure 10 a crank mechanism is shown driving a cross-head. The elastic coupling member is here shown to consist of a flat spring 62, and the oscillating system 63, 64 is represented by a cross-head 63 mounted in a sliding surface and the spiral springs 64, 64. In this case likewise the collecting springs may be flat springs, and it would be possible in this connection to make use of air cushions or the like, instead of steel springs, as in Figs. 2 and 3.

If the mechanism according to this invention is employed in connection with explosion engines, steam engines, or other power engines the following possibilities will result: First, the elastic means of the oscillating system may be located outside of the working cylinder in the form of springs or as separate compression cylinders as shown in Figure 11; or, second, the compression chambers which serve for the collection or accumulation of energy cooperate with the working chambers which are intended for the subsequent furnishing of the energies to be consumed, as shown in Figure 12.

In Figure 11 the working chambers of a two cycle engine are indicated at I, and II, for example, in a steam engine. The piston 65 is moved by the entering steam to the left and right in this chamber, and in this movement it carries the two pistons 66, 66 connected therewith, along with it. If the piston is displaced toward the right a compression is effected in the chamber β , while by moving the piston to the left, a compression

is effected in the chamber α . The mass 66, 65, 66 in combination with the compressed air cushion represents the oscillating system which assumes an amplitude of more or less extent in accordance with the amount of steam flowing into the working cylinder.

Figure 12 shows by way of example, an embodiment of my invention in a four cycle explosion engine in which the explosions in the several cylinders take place, for instance in the succession I, IV, II, III. Directly before the explosion period there will be inserted in every case the compressed cushion of air, which in the present instance is used at the same time for the accumulation of energies of oscillation. Any energy to be transmitted to the outside is transmitted in this case from the rod connecting the pistons.

In Fig. 13 the invention is shown as applied to the mechanism of a percussion tool in which the elastic coupling 67 is excited by a rotating electric motor 68, crank 69 and crank rod 70. This elastic coupling transmits its tension to the hammer 71 which is mounted within the springs 72 and is retained thereby. As soon as the motor rotates with a number of revolutions coinciding with the oscillations of the system 71, 72, the total output is transmitted to said system 71, 72, and may be utilized for practical purposes in the shape of chiseling, riveting or other percussion work or the like. It is, of course, possible also in this case to use air cushions instead of steel springs, for the purpose of coupling as well as for the purpose of accumulation of energy, as in Fig. 3. Moreover, it is possible without further change to employ a fluid, for instance, compressed air, as the operating energy, provided this is done in accordance with this invention so as to cause the operating energy to excite in tune an oscillatable system with a decided individual oscillation.

It has already been pointed out that every oscillatable mechanical system will present both the characteristics of the mass itself, as well as elastic properties. It follows, however, from what has been stated above, that the elastic means may assume very different external configurations; thus, for example, visible springs have been employed in connection with some of the systems, while in other systems invisible earth-field performs the action of the elastic means, as in a pendulum. But it is not only the earth field that may be used as a substitute for the elastic means, but in a general way any field of force may be utilized for the production of mechanical oscillations in combination with a mass; and of these, electric and magnetic fields of force are particularly adaptable.

In Figure 14 an electric motor is shown, whose armature constitutes the mass of a

mechanically oscillating system and in the armature 73 of which an alternating field is created, adapted to impart an oscillating motion to the armature between two field poles n and s , which may be permanent magnets or may be electro-magnets; that is to say, the armature is rotated to one side, and then to the other side. From this it will be seen that the oscillating movements referred to may be greatly assisted by a torsional spring so as to produce an increased action. Thus, the magnetic alternating field constitutes in this case the elastic coupling, it being evidently immaterial whether this alternating field is produced in the armature or in the magnet.

Figures 15 to 17 illustrate a few additional forms of the invention as applied to oscillating electric motors of dynamo machines.

In Figure 15 a mechanical system is connected to the armature of an oscillating motor, which may, for instance, be constructed as in Figure 14, and the mechanical system may be constructed as in Figure 9, so that upon the oscillation of the armature the mechanically oscillating system consisting of the vane or blade 75 is made to oscillate, and becomes adapted to produce work by moving a gaseous or liquid agent. By this means a simple oscillating electrically operated propeller is obtained which in the case of tuned systems is of superior efficiency, and which may be employed in different places for the feeding or the propulsion of gaseous and liquid substances or for starting purposes.

Figure 16 is a diagrammatic illustration of an armature oscillating in a torque field. This armature also, as shown in Figure 14, has to be connected with an elastic member, as a torsion spring, to tune the armature in conformity with the period of the triphase current. By exciting the armature by means of a torque field it will first be moved in the direction of the field, and thereby produce a steadily increasing tension in the elastic member. By means of this tension the slip between the torque field and the armature is augmented, until the action between the field and the armature changes its direction and the armature is repulsed and oppositely rotated assisted by the tension of the elastic member. In view of the fact that this procedure will be constantly repeated, the armature is rapidly oscillated.

The motor engines represented in Figures 14 and 16 may be regarded as of the synchronous type, inasmuch as they operate at the same ratio as the exciting alternating current. It is, however, also possible to construct asynchronous motors according to my invention, as shown by way of example in Figure 17. The armature 76 of the motor, Figure 17, is provided with a so-called repulsion winding which consists ordinarily of the

coils 77, 78 and 79 in the normal operation. If the two magnetic coils 80 and 81 are excited by an alternating current that armature coil, as is well known, is attracted to the pole which is short circuited. Thus, for instance, if in the position of the drawing in which the coil 77 is disposed between the poles, the coil 78 is short-circuited, the armature would perform a corresponding movement in the clockwise direction. For rotating a motor of this kind it would be necessary to short-circuit the coil 79 after the short-circuiting of the coil 78, and then short-circuit the coil 77, and so on. But if the motor is to be oscillated, the coils should be short-circuited in another order, coil 77, coil 78, coil 77, coil 78, and so on in succession; that is to say the coils 77 and 78 are alternately short-circuited, and the coil 79 may be entirely dispensed with.

Inasmuch as the electric motor upon the short-circuiting of one of the coils moves through the space up to the short-circuiting of the succeeding coil in accordance with the strength of the existing field, and therefore with different velocity, the motor may perform quicker or slower oscillations, and may be started with full load, that is to say an asynchronous motor is obtained. In order to perform oscillations of a certain velocity it may be connected to an elastic member which possesses an oscillating period of its own in conformity with the mass of the armature of the motor. By suitably tuning the parts (by varying the individual periods) the particular motor may be adjusted for any desired number of oscillations.

In order to be able to tune any of the systems above described in conformity with any other system in accordance with this invention it is necessary to provide for variation of the number of revolutions of the exciting system or of the individual oscillating period of the excited system. The object last mentioned may be performed by the displacement of the elastic means, thus, for instance, of the point of fastening of springs, or of the end of a compression cylinder, by which means the compression space is reduced; or by the control of valves and by a changing of the pressure with which the valves are forced upon their seats, or by a change of the gas mixture, or of the gas or steam pressure, and by equivalent means.

The invention is obviously not restricted to the particular forms of application heretofore shown and described, but, it is susceptible of a great many modifications and changes, both in operation and in the arrangement of parts, and it lends itself to various other applications different from those heretofore mentioned, and without deviating from the spirit of the invention the scope of which is herein-after expressed in the claims.

By "oscillation" I mean to include the ro-

tary and swinging as well as rectilinear to-and-fro movements.

I claim—

1. In an energy transmitting mechanism, a mass, means to mount the mass to permit it to freely oscillate, driving means for the mass, means included between the driving means and said mass to permit amplitude variation of said mass with respect to the amplitude of the driving means and transmit to such mass the amount of energy sufficient to compensate its damping without altering the free oscillation of said mass.

2. In an energy transmitting mechanism, a mass, means to mount the mass to freely oscillate in its natural period, driving means for said mass, means included between the driving means and mass to permit a variation of amplitude of the mass with respect to the amplitude of the driving means and transmit to the mass the amount of energy necessary to compensate for the damping thereof without varying the natural oscillations of the mass, and means to adjust the oscillations of the mass substantially to the oscillations of the driving means.

3. In an energy transmitting mechanism, a mass, means to mount the mass to oscillate in accordance with its inherent oscillation, driving means for the mass, resilient means included between the driving mechanism and the mass to permit a variation of the amplitude of the mass with respect to the driving means and to transmit to the mass an amount of energy substantially equal to the damping of the mass without changing its period of oscillation, said mass being suitably selected to substantially time the vibrations of the mass to the driving means.

4. In an energy transmitting mechanism, a mass, means to mount the mass to oscillate freely, driving means for the mass, elastic means between the mass and driving means to permit the mass to vary its amplitude with respect to the driving means and transmit energy to the mass as required to compensate for the damping of the oscillations of the mass but insufficient to change the period of oscillation of the mass, and means to tune the oscillations of the mass during its operation substantially to the driving means.

5. In an energy transmitting mechanism, a variable mass, means to mount said mass to freely oscillate, driving means for said mass, means between said mass and driving means to permit the mass to vary its amplitude with respect to the amplitude of the driving means and transmit an amount of energy to the mass to compensate for the damping of its oscillations but not sufficient to change the oscillating period of the mass.

6. In an energy transmitting mechanism, a mass, adjustable means to mount said mass to freely oscillate, driving means for the

mass, means included between the driving means and mass to permit the amplitude of the mass to vary with respect to the amplitude of the driving means and transfer an amount of energy to the mass to compensate for the damping thereof without changing the period of oscillation of the mass.

7. In an energy transmitting mechanism, a mass, means to mount the mass to freely oscillate, means to drive the mass, and adjustable means included between the driving means and mass to permit the amplitude of the mass to vary with respect to the amplitude of the driving means and transfer an amount of energy to the mass to substantially compensate for the damping of the mass but insufficient to change its free oscillation.

8. In an energy transmitting mechanism, a mass, means to mount the mass to freely oscillate, means to drive the mass including an oscillating member, means included between the mass and driving means to transfer to the mass an amount of energy substantially equal to the damping of the mass without altering its natural period of oscillation.

9. In an energy transmitting mechanism, a mass, means to mount the mass to freely oscillate, driving means for the mass and means included between the driving means and mass to permit the mass to vary its amplitude with respect to the amplitude of the driving means and transmit to the mass from the driving means an amount of energy to compensate for the damping of the mass without changing the periodicity of the mass and equal to ΣmV^2 .

10. In a device of the character described, an isochronally reciprocating part, elastic means connected with the mass to receive and store the kinetic energy of the mass, said mass and elastic means forming an oscillating system having a period of oscillation and a crank and a pitman, energy transferring means to connect said pitman to the system to compensate the damping of said system without altering the natural periodicity of the part.

11. In a device of the character described, an isochronally reciprocating mass, adjustable elastic means connected with the mass capable of storing kinetic energy of the mass, said mass and elastic means forming an oscillating system oscillatable in its own period, a driving crank and pitman, energy transferring means connecting the crank and pitman to said system to compensate the damping of the system without changing its isochronism, said crank rotating substantially with the oscillations of the system.

12. In a device of the character described, a reciprocating mass, adjustable elastic means connected therewith capable of taking up and storing the kinetic energy of the mass, said mass and means forming an oscillating system, a crank and pitman energy transfer-

ring means to connect them with said system to transfer to the system energy sufficient to compensate for the damping of the system without changing the periodicity of the mass.

13. In mechanism for transmitting energy, a mass, means to mount said mass to oscillate freely in natural oscillations, driving means for said mass and means interposed between said driving means and said mass to vary its amplitude of movement with respect to the amplitude of the driving means and to transfer such an amount of energy as to compensate the damping of the oscillating mass but insufficient to vary the frequency of the natural oscillations of said mass, and means to tune said driving means and said naturally oscillating mass.

14. In mechanism for transmitting power, a mass, means to mount said mass to oscillate freely in natural oscillations, driving means for the mass and means interposed between said driving means and said naturally oscillating mass to permit the mass to vary its amplitude of movement with respect to the amplitude of the driving means, but insufficient to vary the frequency of the natural oscillations of said mass, means to tune said driving means and said naturally oscillating mass, said interposed means being sufficient to transfer such amount of energy as to compensate the damping of the oscillating mass and amounting to ΣmV^2 .

15. In mechanism for transmitting energy, a mass, means to mount said mass to oscillate freely in natural oscillations, driving means for said mass and means to tune said driving means and said naturally oscillating mass and means interposed between said driving means and said mass to vary its amplitude of movement with respect to the amplitude of the driving means and to transfer such an amount of energy as to compensate the damping of the oscillating mass but insufficient to vary the frequency of the natural oscillations of said mass, said interposed means adapted to be adjusted for the amount of energy required to be transmitted.

16. In a device of the character described, an isochronally reciprocating part, elastic means operatively connected to the reciprocating part adapted to absorb and restore the momentum thereof, the said elastic means being loaded by said reciprocating part, both parts forming an oscillatory system adapted to be driven at the natural period of reciprocation thereof, and a crank and pitman operatively connected to said oscillatory system and having substantially corresponding frequency, and a second and weaker elastic means connecting the crank and pitman and the oscillatory system.

17. In a device of the character described and in combination, an isochronally reciprocating part, elastic means operatively connected to the reciprocating part and adapted

to absorb and restore the momentum thereof, said elastic means being loaded by said reciprocating part and both parts forming an oscillatory system driven at the natural period of reciprocation thereof, and a crank and pitman operatively connected to said oscillatory system and having corresponding frequency, and a second and weaker elastic means connected between the crank and pitman and the oscillatory system, and adjusting means operatively connected to said second elastic means. 10

• In testimony whereof I affix my signature.

GEORG HEINRICH SCHIEFERSTEIN.