Sept. 22, 1925. 1,554,254

E. ZBINDEN

ELECTROMAGNETIC POWER DEVICE

Filed Dec. 14, 1923

Fig. 1.

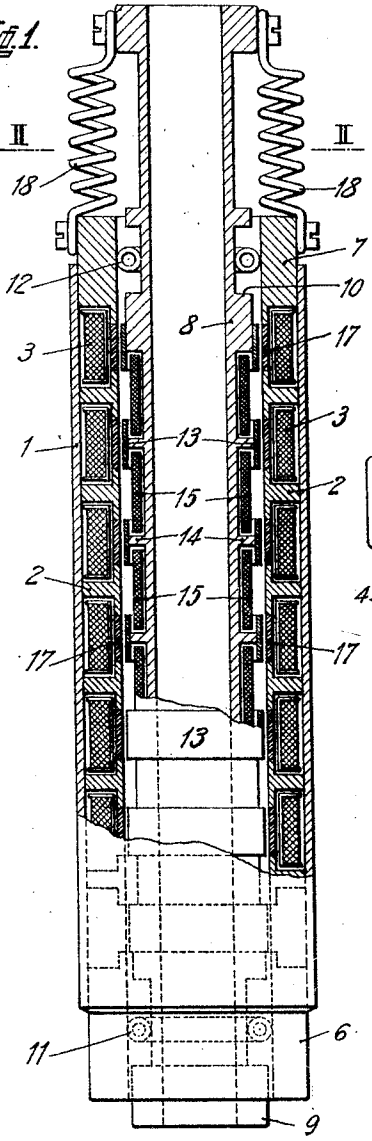


Fig. 2.

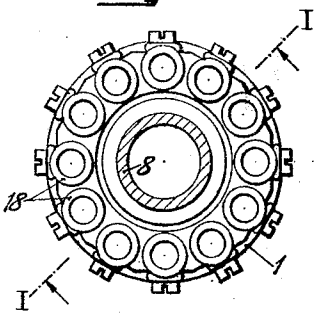
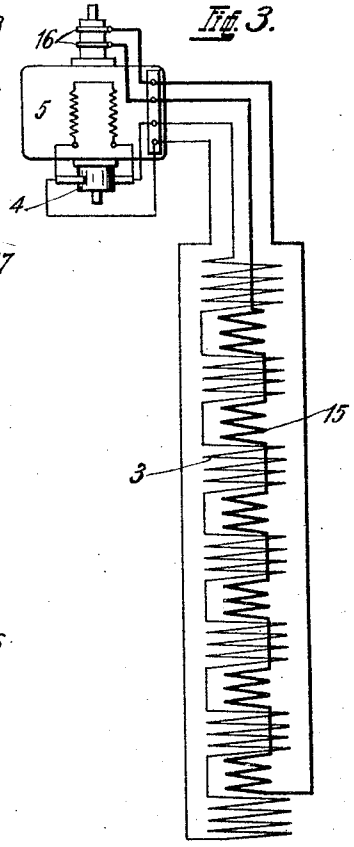


Fig. 3.



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UNITED STATES PATENT OFFICE.

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ELECTROMAGNETIC POWER DEVICE.

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To all whom it may concern:

Be it known that I, EMILE ZBINDEN, a citizen of Switzerland, residing at Berne, Switzerland, have invented certain new and useful Improvements in Electromagnetic Power Devices, of which the following is a specification.

The present invention has reference to improvements in electromagnetic tools and relates more specifically to that class of electromagnetic power devices in which by the cooperation of continuous and alternating current coils a spring influenced armature is made to reciprocate in synchronism with the alternating current, and the particular object of this invention is to improve the action of the armature-influencing springs by choosing them of different character so that by reason of their individually different natural vibrations or frequency they serve to compensate the irregularities in the operation of the spring system as a whole and also the irregularities in the frequency of the actuating current, which irregularities in the prior art have been found to seriously interfere with the proper operation of the device and often are the cause of fracture of one or more springs.

Cylindrically coiled springs, which are caused to vibrate in axial direction, do not vibrate evenly throughout. There will be set up nodal points where no oscillations will occur and between such nodes bulges or loops will develop, very apt to cause in time fracture owing to local excess stresses. Furthermore, such partial oscillations will injuriously affect the proper operation of the armature, inasmuch as in the known devices of this character the armature and spring system or unit does not vibrate on a pure sine line, but on a deformed wave line caused by wave superimposition.

The use of a single spring or several identical springs in this connection, thus, is conducive not only to fracture of the springs but also to uneven operation of the armature by reason of the stated partial oscillations.

In order to do away with these serious drawbacks I employ for the indicated purposes a plurality of springs, each of which differs in natural vibration from every other spring of the system, with the result that combined they compensate to a large degree the individual vibrations, and a mean natural periodicity of the spring system is obtained which overcomes or paralyzes the local excess stresses and thereby obviates or at least greatly reduces the danger of fractures and assures the perfectly timed and evenly powered operation of the armature.

The natural frequency of the armature-spring suspension system is to be so chosen that it falls below the frequency of the alternating current, whereby important advantages are obtained. In order to operate properly the tool must have the character of an electromotor showing the same amplitudes on idle running or under load, that is to say, the armature must show a constant deflection, and one of considerably less extent than if the frequencies were identical. The constancy of the deflections, however, aside from the weight of the armature and of the force and formation of the pole pieces, is dependent upon the choice of the spring suspension. If the natural frequency of the springs-armature system is equal to the frequency of the alternating current, then a considerable deflection of the armature is obtained, but the uniform sine oscillation of the system would seriously be affected by the tool operation. On the other hand, the tool operation would not proceed in a normal manner, since the best effect is obtained only when the armature oscillations develop on a pure sine line, that is to say at a constant amplitude.

If the natural frequency of the system is chosen to be higher than the current frequency, it is true, the armature can also be vibrated but in this instance with but little force, and it can readily be seen that a constant deflection with and without load cannot be obtained.

If, however, according to my invention, the natural frequency of the armature and spring suspension system is chosen to be below the frequency of the alternating current, then the armature will show the tendency to lag within the phase relative to the current. It will then be entrained by the latter, remaining in step therewith, as it were, with the effect that even strokes of constant force result.

The device, thus, already on running idle is loaded to some extent owing to this entrainment of the armature. During operation vibrations are set up which practically develop on a pure sine line, because the

springs in each reciprocation of the armature are forced to do double duty, being first compressed and then extended again, for contrary to the prior devices of this character, no special stop means are provided for limiting the reciprocations of the armature. On starting, the armature immediately falls in step with the current and the amplitude of its oscillations rapidly increases until it has reached its normal rate.

In order to make my invention more readily understood, I will now describe it in connection with the accompanying drawing, in which Fig. 1 is a longitudinal section through the new device on line I—I of Fig. 2, which latter is a cross-section on line II—II of Fig. 1. Fig. 3 illustrates schematically the electrical connections.

The shell or case 1, representing the stator, contains coils 3 which alternate with pole shoes 2. The coils are fed from a continuous current source 4 and are so interconnected that each two adjacent magnet fields are of opposite polarities. The axially reciprocating armature 8, suitably guided in the stator as at 11 and 12, is provided with coils 15 connected to a source of alternating current, as at 16, and so interconnected that the respectively adjacent magnet fields show opposite polarity. Annular pole members 13, supported on annular ribs 14, partly cover-in the coils 15. The pole pitch, that is the distance between the centers of each two pole pieces, of the coils 15 is identical to that of the coils 3. The interspaces 17 between the pole shoes 2 are filled with nonmagnetic material and their width is substantially that of the pole members 13. The co-operation of the coils 3 and 15 is well known in the art and need not be enlarged upon here.

Between the armature and the stator there is interposed in axial direction a plurality of coiled springs 18, arranged in substantially cage-formation around the protruding armature extremity. These springs thus are easily accessible and are readily demountably secured at their ends to the stator and the armature respectively. The springs are preferably all of different elasticity and serve, aside from their office of normally keeping the armature in the position of rest in which the pole members 13 register with the interspaces 17, to attune the operative periodicity of vibration of the armature to the natural period of vibration of the alternating current and also to practically eliminate self-vibration in the individual springs.

Special stop means to limit the operative displacements of the armature are not needed, the spring suspension system by itself fully serving this purpose.

What I claim is:—

1. In a reciprocating electromagnetic power device of the character set forth, in combination, a stator, an armature axially reciprocable therein, and a plurality of axially directed cylindrically coiled control springs of individually different natural frequency arranged substantially in cage formation about said armature and their extremities respectively secured to said stator and said armature.

2. In a reciprocating electromagnetic power device of the character set forth, operable by alternating and direct current, in combination, a stator, an axially reciprocable armature in said stator, and means interposed between said stator and said armature for attuning the periodicity of reciprocation of said armature to that of the alternating current and for eliminating self-vibration in these attuning means, comprising a plurality of cylindrically coiled control springs of individually different frequencies and so chosen that the natural frequency of all of these springs together with the armature is below that of the alternating current.

EMILE ZBINDEN.