March 4, 1924. 1,486,040

G. H. SCHIEFERSTEIN

TUNED MECHANICALLY OSCILLATING SYSTEM

Filed Aug. 24, 1921

Fig. 1.

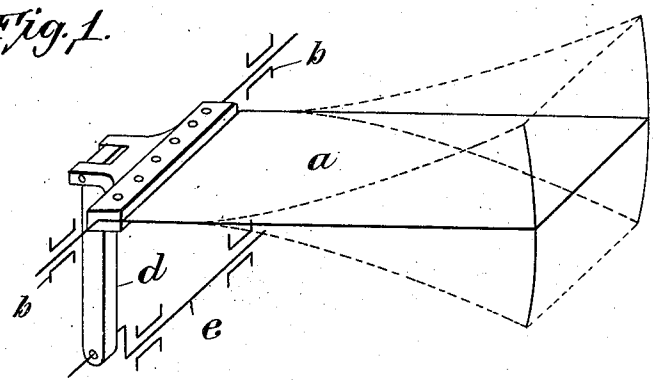
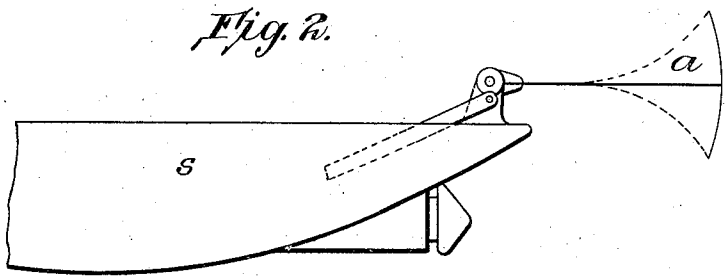


Fig. 2.



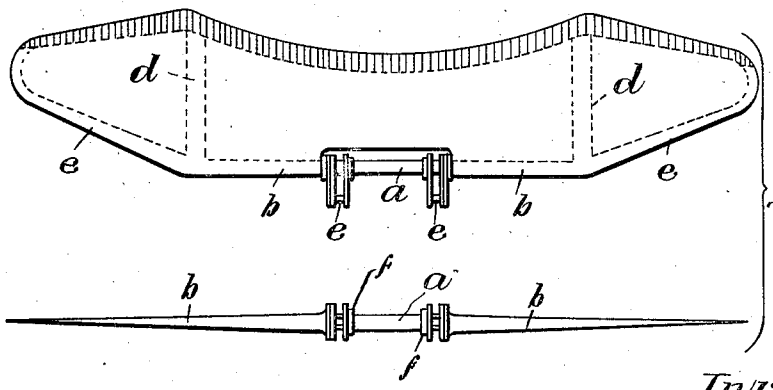


Fig. 3.

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UNITED STATES PATENT OFFICE.

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TUNED MECHANICALLY-OSCILLATING SYSTEM.

Application filed August 24, 1921. Serial No. 495,142.

(GRANTED UNDER THE PROVISIONS OF THE ACT OF MARCH 3, 1921, 41 STAT. L., 1313.)

To all whom it may concern:

Be it known that I, GEORG HEINRICH SCHIEFERSTEIN, a citizen of the German Republic, residing at Charlottenburg, near Berlin, Germany, have invented certain new and useful Improvements in a Tuned Mechanically-Oscillating System (for which I have filed application in Germany February 15, 1919), of which the following is a specification.

This invention relates to a method of propulsion through fluid media by means of high frequency mechanical oscillations set up in a resilient flexible blade or surface by any suitable source of power and acting upon the medium (air or water) in which the blade is immersed.

Heretofore, it has not been practicable to make use of blades or the like, for power or propulsion purposes, oscillated at a high rate of speed (for example, over 100 oscillations per minute), on account of the low efficiency obtained, due to the inertia of the moving mass of the blade which has to be brought to rest, its direction of motion reversed, accelerated to a maximum speed in the center of its path of travel, and again retarded to zero speed. The low efficiency obtained has heretofore been considered as inseparable from this form of apparatus and consequently, it has not been made practical use of except at low speeds. It is the object of the present invention to so arrange, construct and operate such apparatus that it will be very efficient at high speeds, I find that speeds of from 4000 to 10,000 oscillations per minute can be attained, with an efficiency of 80%, whereby very considerable propulsive power is delivered.

The essential features of the invention are, 1, the employment of an elastic plane, in other words, a resilient flexible blade, in place of a rigid one. 2, the synchronizing or tuning of the speed of oscillation with the natural period of oscillation of the blade.

The invention is illustrated diagrammatically in the accompanying drawing, in which,

Fig. 1 represents a simple rectangular blade and its actuating means;

Fig. 2 represents such a blade, applied to a vessel, and

Fig. 3 a modified form of blade, especially applicable to the propulsion of aircraft.

When a flexible blade is used, the kinetic energy it acquires in oscillating so acts that the blade flexes or warps near the end of its stroke, as indicated by the dotted lines in Fig. 1, in which *a* is the flexible blade, *bb* its pivotal axis, *e* the power shaft and *d* the connecting-rod.

The system is inefficient when, at each reversal of motion, the energy stored in the flexed blade is given up too quickly or too slowly. But when the delivery of the stored energy is perfectly in unison with the return movement, a condition of maximum efficiency is attained. This is the case when the speed of the driving shaft agrees with the natural period of oscillation of the flexible blade, or in other words, when the primary oscillatory system, consisting of the source of power, the crankshaft and the rigid portion of the blade, is synchronized with the natural oscillation of the secondary oscillating system, consisting of the flexible portion *a* of the blade.

If the motor is run slowly, the following may be observed: The sheet or plane *a* oscillates through a certain angle with a number of oscillations per second corresponding with the speed of the motor. As the motor speed rises the oscillations of the plane *a* of course increase and one can determine by accurate observation that the warping of the surface *a* increases a little in accordance with the increasing storage of energy. On the speed of the motor being further increased, a condition suddenly arises wherein the warp of the plane *a*, in its end positions, suddenly increases a considerable amount, that is, the amplitude of the oscillation reaches a maximum which lessens again with still increased motor speed. The critical speed whereat this maximum occurs is that corresponding with the natural oscillation of the elastic system and that at which the efficiency of the entire arrangement attains a maximum. To obtain this condition the speed of the motor may be adjusted for, where a motor of fixed speed is employed, the natural oscillation of the surface *a* may be suitably adjusted similarly to that of a tuning fork.

Fig. 2 illustrates an application of the aforesaid principle to propulsion. The elastically oscillating plane *a* is for this purpose set up at the stern end of a surface boat. In this case also the plane *a* is actuated by a

rod in tune with its natural oscillation and owing to the reaction of the air flowing away or propelled, there is brought into action a propulsion in the present instance for driving the vessel. Since as follows from the above the mechanical efficiency of such an arrangement must be quite a favourable one, and since, further, there is nothing against mounting on one and the same vessel or other vehicle comparatively large oscillating planes, in some cases several complete outfits, it is quite evident that in vehicles for high speed this kind of drive may offer advantages even where very considerable power is involved.

It is quite obvious that the oscillating plane *a* (Fig. 2) might move about a vertical axis instead of a horizontal one, or about one set at a desired angle, without any change in the action being anticipated.

Moreover it is possible to arrange the aforesaid mechanism in liquid media, e. g., in water. An example from nature is the tail of the fish whereby propulsion is effected by the same action.

It is clear from the above that the aforesaid propelling mechanism can be employed in principle for all vehicles which are self-propelled in gaseous or liquid media (air, water). As specially applicable may be now mentioned motor-sleighs or automobiles which must traverse sandy places, e. g., deserts. The propelling mechanism for these does not differ in principle from that shown in Fig. 2.

Where efficiency is referred to in the above, it is the efficiency between the source of power and the device transferring the energy, the oscillating system. This efficiency, as shown, is mainly influenced by the resonance phenomenon. It is always advantageous that the elastically oscillating system works with the source of power in resonance (tuned) and it is the more unfavourable the more the speed of the generator differs from resonance speed. For excellence in a complete apparatus of the aforesaid kind, however, the efficiency of the source of power in itself and the aerodynamic or hydrodynamic efficiency have an influence.

Concerning the aerodynamic or hydrodynamic efficiency to be expected, one can best obtain a clear idea by comparing the above-described device with the ordinary propeller system.

The ordinary propeller is always driven through the gaseous or liquid medium in the direction of its rotary axis and consequently, when calculating the propeller resistance, it has been usual to take into account its entire projected surface. In the present system the projected surface for equal loads is obviously far less and on this account an essential improvement in aerodynamic or hydrodynamic efficiency is to be expected.

As a still more striking indication of the obtainable aerodynamic or hydrodynamic efficiency is the consideration whether it will be possible so to set in motion the gaseous or liquid medium for rearward flow that useless and deleterious eddies will be obviated. As has been proved by experiment and research it is desirable for this purpose to make the oscillating surfaces towards their edge as free from inertia and as flexible as possible, as is observable in the fins of fish and in the wings of objects in nature.

Fig. 3 shows by the shading such an edge. This edge may be made to suit the amount of energy transmitted or the specific surface pressure and may consist of an elastic steel skeleton jacketed with fabric or it might be formed by separate elastic laminæ.

Further it is desirable, as shown in Fig. 3, to extend the strongly oscillating lateral ends of the oscillating planes by an added extension which shares each oscillation with no pronounced natural oscillation, that is, is aperiodic. In Fig. 3 these portions have the form of a triangle rounded off at the apex and are bounded towards the plane by the springs *d*, *d* or *e*, *e*. By these means strongly driven air strata or dangerous eddies which form at these places with rectangular planes are gradually changed into less strongly moved strata or made innocuous.

The planes in themselves may be made of elastic, homogenous material (steel, bronze, &c.), they may however comprise metallic ribs connected by sail-cloth or other suitable covering. Moreover the oscillating surfaces might consist of several, independently oscillating, separate planes.

In all the devices above described the basis intention is that the plane oscillates in a $\frac{1}{4}$ wave. It is however possible to move the ambient medium if the said plane works with more than a $\frac{1}{4}$ oscillation, for example a $\frac{3}{4}$ or $\frac{5}{4}$ or more. Similar effects can be observed in fish. Also for certain purposes oscillating planes may be employed which move approximately aperiodically, that is, planes which within certain limits respond to predetermined oscillations.

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

1. The method of propulsion in a fluid medium, which consists in setting up high frequency oscillations in a flexible blade by vibrating it at a rate of speed synchronized or in tune with the natural period of oscillation of said blade.

2. The method of propulsion in a fluid medium, which comprises setting up high frequency oscillations in a flexible propelling blade by vibrating its body portion at a rate of speed synchronized or in tune with

the natural period of oscillation of said blade and producing aperiodic oscillation of the marginal portions of such blade.

3. Propelling mechanism, comprising a flexible blade having marginal portions differing in flexibility from the blade, and means to vibrate said blade in unison or in tune with the natural vibration of the body portion of the blade, whereby said marginal portions will move aperiodically with respect to the body portion of said blade.

4. Propelling mechanism for fluid media, comprising a resilient skeleton frame, a non-resilient fabric stretched over said frame and means vibrating said frame in synchronism with its natural period of vibration.

5. Propelling mechanism for fluid media, comprising a resilient wing having lateral portions of small mass and aperiodic with respect to the body of the wing, and mechanism vibrating said wing in synchronism with its own period of vibration.

6. Propelling mechanism, comprising a resilient wing having lateral triangular aperiodic portions, and mechanism vibrating said wing in synchronism with its natural period of vibration.

7. The method of propulsion in fluid media, which comprises setting up high frequency oscillations in a flexible blade by vibrating it at a rate synchronized or in tune with its natural vibration, said blade oscillating in a quarter wave.

In testimony whereof I affix my signature.

GEORG HEINRICH SCHIEFERSTEIN.