

Oct. 24, 1967

W. EISSFELDT

3,348,376

GENERATOR OF HIGH FREQUENCY OSCILLATIONS

Filed Oct. 20, 1965

4 Sheets-Sheet 1

Fig. 1

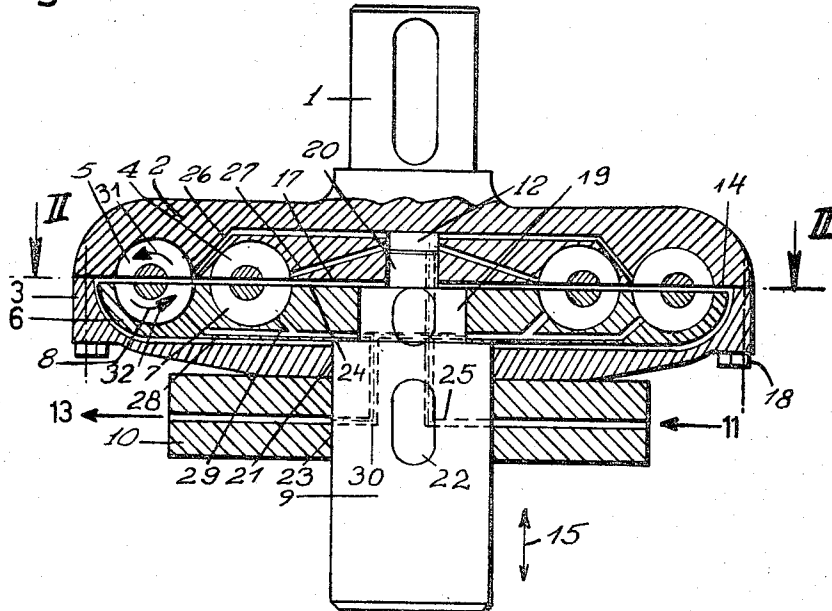
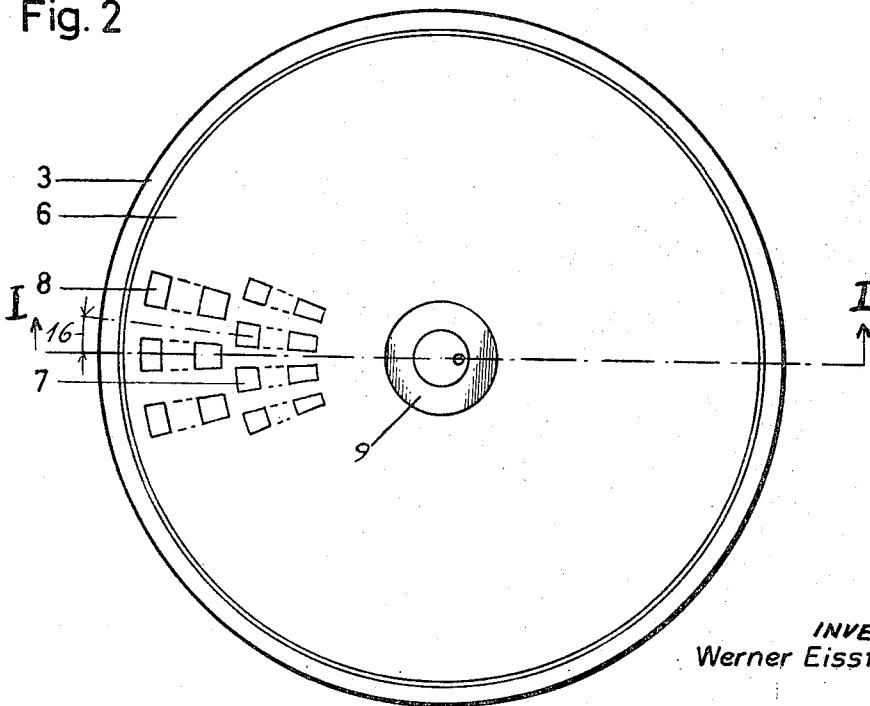


Fig. 2



INVENTOR:
Werner Eissfeldt

BY Ross & Mestern

Oct. 24, 1967

W. EISSFELDT

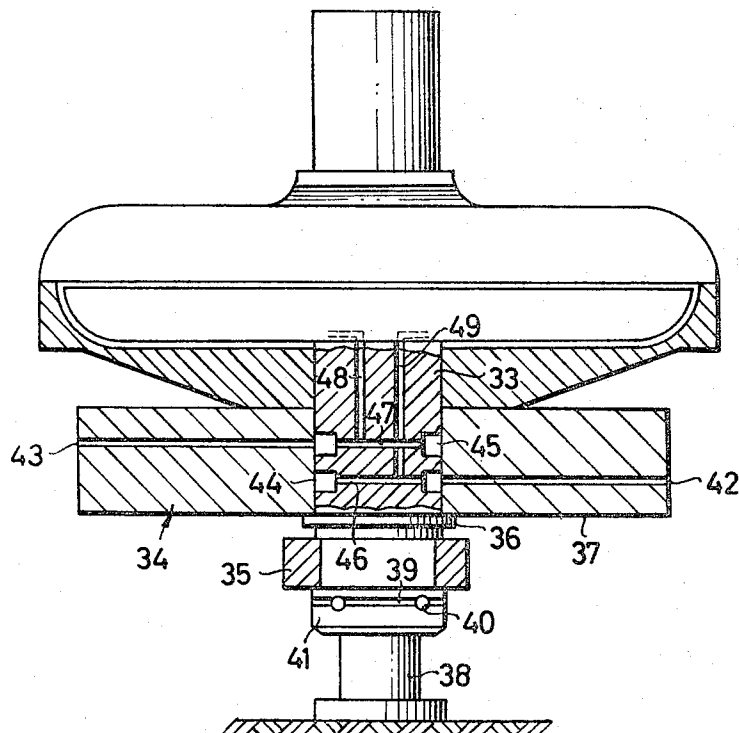
3,348,376

GENERATOR OF HIGH FREQUENCY OSCILLATIONS

Filed Oct. 20, 1965

4 Sheets-Sheet 2

FIG. 3



INVENTOR:
Werner Eissfeldt

BY
Ross & Mestern

Oct. 24, 1967

W. EISSFELDT

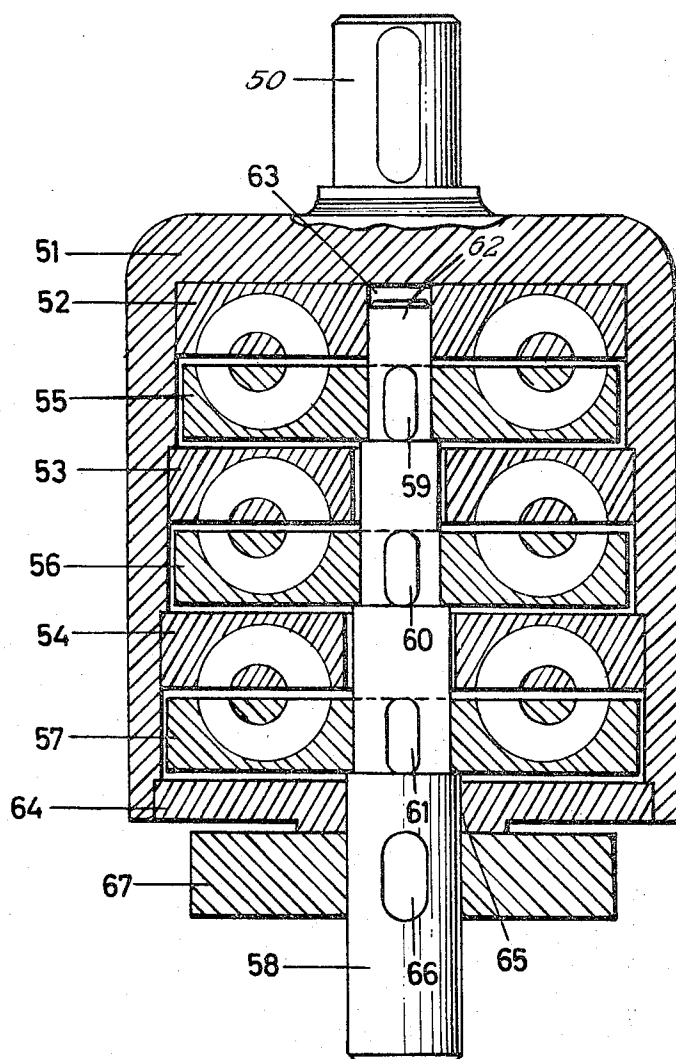
3,348,376

GENERATOR OF HIGH FREQUENCY OSCILLATIONS

Filed Oct. 20, 1965

4 Sheets-Sheet 3

Fig. 4



INVENTOR:
Werner Eissfeldt

BY *Ross & Mestern*

Oct. 24, 1967

W. EISSFELDT

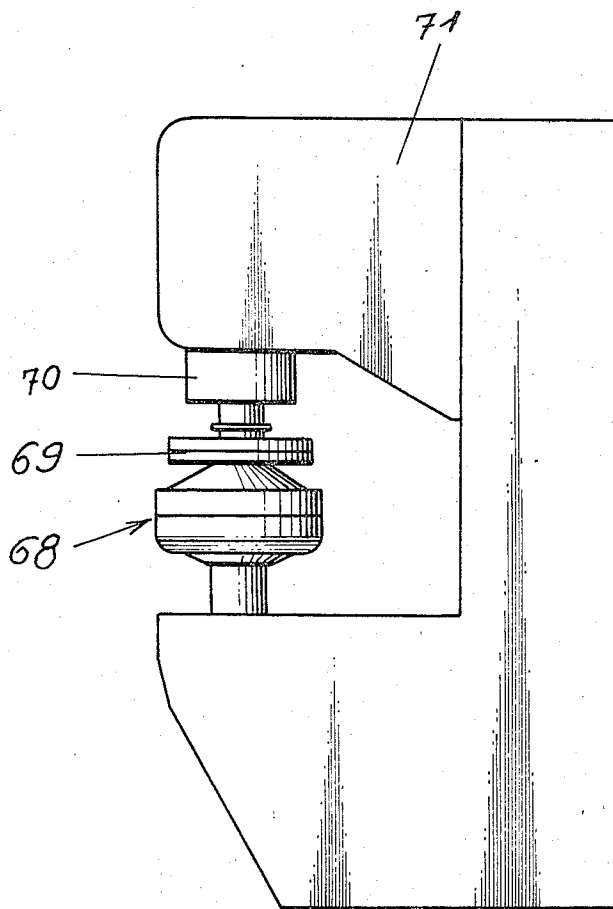
3,348,376

GENERATOR OF HIGH FREQUENCY OSCILLATIONS

Filed Oct. 20, 1965

4 Sheets-Sheet 4

Fig. 5



1

3,348,376 GENERATOR OF HIGH FREQUENCY OSCILLATIONS

Werner Eissfeldt, 15 Buchnerstrasse,
Darmstadt 61, Germany

Filed Oct. 20, 1965, Ser. No. 498,784

Claims priority, application Germany, June 10, 1965,

N 26,854

10 Claims. (Cl. 60—54)

ABSTRACT OF THE DISCLOSURE

A high-frequency oscillation generator having a pump rotor with a pumping face transverse to the axis of rotation thereof and driven by a source of motive power, and a motor rotor axially aligned with the pump rotor and having a face confronting same, one of the shafts of the hydraulic clutch formed thereby being axially oscillated upon relative rotation of the rotors, the rotors having confronting chambers for inducing centrifugal flow of hydraulic fluid between the chambers of the confronting rotors in the manner of a fluid coupling.

High-frequency oscillations, especially if within the range of ultrasonic frequencies, are used in various fields of production and medicine. In most cases, complicated electrical apparatus is used in known systems for the generation of such ultrasonic oscillations. It has also been suggested to generate such oscillations in air or in a fluid according to the principle of a flute or a siren (multi-hole disc). With an oscillation generator operating in accordance with the principle of the flute, one can achieve the required oscillation energy through amplification, but this was not possible with the second kind of oscillation generator, i.e. the type constructed according to the principle of the siren, so that such apparatus has not become generally accepted.

The object of the invention is the construction of an oscillation generator for high-frequency oscillation in the ultrasonic range which does not require a complicated electrical apparatus, but nevertheless emits sufficient oscillation energy, and which finally requires little space and can be economically manufactured.

The solution of the problem underlying the invention consists in utilizing the hydraulic force of known hydraulic clutches, especially those of the Föttinger system, for the generation of high-frequency pulses. According to the invention, the construction of the oscillation generator corresponds essentially to known hydraulic clutches, both a pump and also a motor or turbine wheel or rotor being used. The difference lies in the fact that the fins of the pump and the motor wheel are aligned in the same direction and that the motor wheel is braked to prevention of rotation.

According to the invention, the hydraulic forces acting on the motor wheel generate oscillations, especially longitudinal oscillations, mainly in the direction of the motor-shaft axis.

The drawing shows the invention in two embodiments. FIG. 1 is an elevational view, partially in axial section along the line I—I of FIG. 2 of an oscillation generator according to this invention.

FIG. 2 is a plan view of the oscillation generator with its pump wheel removed, the view being taken along the line II—II of FIG. 1.

2

FIG. 3 is a partial vertical section through another embodiment of the apparatus, in which the motor shaft has been braked.

FIG. 4 is a partial elevation and a partial axial section through another exemplary embodiment of oscillation generator possessing several sets of wheels.

FIG. 5 is an elevational view of the generator-support and assembly.

In the embodiment of FIGS. 1 and 2, the oscillation generator consists of a pump wheel 2, which is rotated by a vertical drive shaft 1. On the lower face 17 of the pump wheel, part of a casing 3 is connected by means of screws 18, the motor wheel 6 being keyed onto a section 19 of the motor shaft 9 of smaller diameter and being located in the interior of the casing. With a section of still smaller diameter 20, the motor shaft 9 juts into a bore 12 of the pump wheel 2. The motor shaft 9 passes through a bore 21 in the casing 3 and is supported in a bore 23 of a base 10, where it is secured against rotation by means of a key 22.

Departing from the surfaces 17 and 24 of the pump and motor wheels respectively, which face each other, there are provided in two concentric circles and exactly facing each other a large number of flow channels 4, 5 and 7, 8 of approximately semi-circular cross section. The channels in the concentric circles are offset by half their separation 16 with respect to one another, as can be seen from FIG. 2. In the embodiment shown, there are 200 single channels in each circle. The braking fluid is piped by means of pipe channels to and from the brake channels 4, 5 and 7, 8. The supply channel 11 ends in the base 10 and is then connected by a channel 25 provided in the motor shaft 9 to a distributing space 12, which is provided in the interior of the pump wheel above the section 20. From this distributing space 12, further channels 26, 27 lead to the brake channels 5, 4 respectively. From the brake channels 7, 8, further channels 28, 29 extend to a collecting channel 30 within the motor shaft and continue via an exit channel 13 within the base 10 to the exterior.

The device functions as follows: If the drive shaft is driven, for instance, at 3,000 r.p.m., then the longitudinal oscillation of the motor shaft has a frequency of 20,000 c.p.s.

In order to calculate the flow pressure, the following formula must be used:

$$\text{Centrifugal force} = \text{Mass} \times \text{radius} \times \text{square of the angular velocity}$$

From this formula, one sees that the flow pressure increases with the mass of the fluid used, the size of the pump disc and drive r.p.m. or angular velocity of the pump wheel. Depending on the intended purpose, the output frequency variation can be effected by altering the above factors.

Since the motor wheel 6 has a lower speed than the pump wheel 2, the speed of the motor wheel being possible zero, the channels 4, 5 of the pump wheel are only for a short time exactly opposite to the channels 7, 8 of the motor wheel. Due to the centrifugal force acting on the fluid situated in the channels of the pump wheel, these fluid particles will flow in the direction of the arrow 31 and will exert a flow pressure on the fluid located in the channels 7, 8 of the motor wheel 6, so that these fluid particles will flow in the direction of the arrow 32.

Due to the velocity difference between the pump wheel

and the motor wheel, the channels 4, 5 and 7, 8 after being opposite to each other for a short time, will more or less be momentarily disconnected from each other until they are opposite each other the next time, so that the flow velocity in these channels is progressively braked to nearly zero, thereafter increasing again progressively. The braking has a sinusoidal axial effect on the motor wheel 6 and thus leads to a longitudinal oscillation in the motor shaft 9.

In order to alter the power of the apparatus, the distance between the pump wheel and the motor wheel must be changed, which can be effected by means of an adjusting device, with which the motor shaft 9, and with it the motor wheel 6, can be adjusted with respect to the pump wheel.

This power regulation of the apparatus can also be effected automatically during operation by exerting via the motor shaft 9 an upwardly directed pressure on the motor wheel 6 when placing the apparatus on the workpiece to be treated, so that, starting from zero, the power rises gradually, corresponding to the nearness of the motor wheel 6 to the pump wheel 2.

The system of supply and drain channels for the fluid serves the purpose of removing the heat created and for insuring that the fluid fills the braking channels. The pump wheel 2 conveys the fluid from the distributing space 12 via the lines 26 and 27 into the braking channels 4, 5, the fluid being automatically sucked in through the supply channel 11. Since the motor wheel 6 only has a low speed or is prevented from any rotation, the fluid can drain via the channels 28, 29 into the drain channel 13 due to the lack of centrifugal force.

For cooling, the fluid leaving the channel 13 is piped through a sufficiently large container or a long pipe system back to the supply channel 11, the fluid path being dimensioned to provide sufficient time to dissipate the heat.

With especially high loads, it could be useful to provide a flow of cooling air produced by the drive motor via a blower that cools the circulating fluid in a pipe system.

It is necessary to provide the supply channel 11, the drain channel 13 and the connection channels 25 to 30 with such small cross sections relative to that of braking channels 4, 5 and 7, 8, that the power loss resulting from the flow channels is kept as low as required.

In the embodiment of FIG. 3, the motor shaft 33 is supported rotatably within the base 34. In order to keep the rotational speed of this motor shaft lower than that of the pump wheel, a regulatable brake 35 is provided below the base 34. In order to limit the longitudinal oscillations of the motor shaft, there is provided a shoulder 36 below the base 34, which acts as a stop against the lower surface 37 of the base 34 and thus guarantees that the necessary minimum play is retained between the surfaces of the motor wheel and the pump wheel facing each other, and that grinding of the pump wheel on the motor wheel is prevented.

By contrast with the system in which the motor shaft is prevented from rotating, this embodiment can have the advantage that one can regulate both the power and the frequency of the longitudinal oscillations of the motor shaft, since the degree of braking alters the rotational speed of the motor shaft from zero to any desired value, whereby the difference between the velocity pump wheel and the motor wheel (i.e. the relative angular velocity) can be regulated without it being the need to alter the speed of the drive shaft. On the other hand, a large range of regulation can be achieved by changing both the rpm of the drive shaft and the rpm of the motor shaft by corresponding braking, which can be of advantage for certain types of work.

In order to prevent transfer of the angular velocity of the motor shaft 33 to the workpiece 38, I provide a thrust ball-bearing 40 and an annular disc 41 at the lower face 39 of the motor shaft 33. When placing the apparatus

on the workpiece 38, this ring 41 will transfer only the longitudinal oscillations to the workpiece, but not the rotational movement of the motor shaft.

In order to pipe the fluid via the supply line 42 into the system and drain it via the drain line 43, these lines are provided in the base 34 displaced in height with respect to each other. They each lead to an annular channel 44, 45 in the motor shaft 33 and are connected via the connection channels 46, 47 with the further supply channels and drain channels 48, 49 respectively.

The embodiment of the FIG. 4 is an oscillation generator with several sets of pump and motor wheels. The drive shaft 50 rotates a cylindrical pump casing 51, in which there are mounted rigidly a number of pump wheels 52, 53, 54 that are axially spaced. Between these wheels, the motor wheels 55, 56, 57 can be inserted, which are mounted by keys 59, 60, 61 respectively on a motor shaft. For the easy mounting of these motor wheels on the motor shaft, the latter decreases in diameter from wheel to wheel. The extreme end of the motor shaft 58 is designed as section 62 and is supported in a bore 63 of the first pump wheel 52 as with the first exemplary embodiment.

The pump casing 51 is sealed towards the bottom by the cover 64, through the bore 65 of which the motor shaft 58 passes, which is connected by a wedge 66 with the base 67. Also with this line channels not shown in the drawing are provided, which serve to transfer fluid into and out of the apparatus and for cooling. In FIG. 5, the generator 68 of FIGS. 1 and 2, 3 or 4 is shown to be held against the workpiece 69, for treatment by ultrasonic vibration, in a press whose frame 71 carries the workpiece holder 70.

I claim:

1. A high-frequency oscillation generator, comprising a pair of axially aligned rotors having confronting faces transverse to their axes and formed with confronting angularly spaced fluid compartments adapted to induce a centrifugal flow of fluid between the compartments of said rotors upon relative rotation thereof, at least one of said rotors being axially oscillatable for transferring vibrations to a body, input means for driving a pumping one of said rotors for inducing a hydraulic-fluid flow between said compartments, and means for restricting the rotation of the other, driven rotor relative to the pump rotor.

2. A generator defined in claim 1 wherein each of said rotors is formed with a multiplicity of torque-converter fins defining the respective compartments between them, the fins of the pump and driven rotors being aligned in the same direction, said generator further comprising a first vertical shaft drivingly connected with the pump rotor, a second vertical shaft axially aligned with the first vertical shaft and drivingly connected with the driven rotor, and a casing connected to said pump rotor and surrounding said driven rotor while rotating relatively to said second shaft.

3. A generator defined in claim 2, further comprising a base keyed to said second shaft and provided with inlet and outlet ducts for delivering hydraulic fluid to and removing it from said compartments.

4. A generator defined in claim 2 wherein each of the faces of said rotors are provided with a multiplicity of concentric circular rows of angularly equispaced compartments with the chambers of the adjacent rows of each face being angularly offset by half the spacing between the compartments.

5. A generator defined in claim 2 wherein at least one of said shafts is provided with a plurality of fluid channels for delivering hydraulic fluid to and removing it from said compartments.

6. A generator defined in claim 2, further comprising means for adjusting the axial spacing of the faces of said rotors to vary the energy of the axial oscillations generated by the rotors.

7. A generator defined in claim 2 wherein said casing

5

is rotatably supported from below on a base and at least one of said shafts is provided with a thrust bearing for limiting its axial displacement while permitting its rotation relative to a support.

8. A generator defined in claim 7 wherein said base is provided with an inlet channel and an outlet channel for respectively delivering hydraulic fluid to and removing it from said compartment.

9. A generator defined in claim 2 wherein a plurality of axially spaced pump rotors and driven rotors are inter-

6

leaved axially and rotatably entrained by said casing and said second shaft while bearing against shoulders of said casing and said second shaft in axial direction.

10. A generator defined in claim 2 wherein the means for restricting rotation of the driven rotor includes a brake for said second shaft.

No references cited.

EDGAR W. GEOGHEGAN, *Primary Examiner.*