

Jan. 6, 1942.

K. WILDE ET AL

2,269,072

CONTROLLING DEVICE

Filed Dec. 19, 1938

3 Sheets-Sheet 1

Fig.1

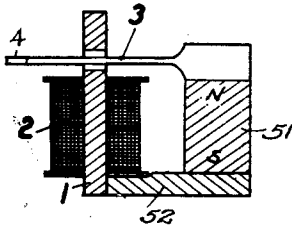


Fig.2

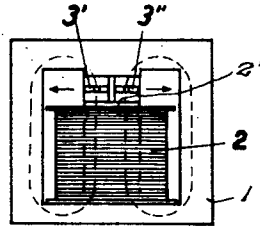


Fig.3



Fig.6

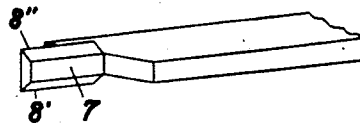


Fig.4

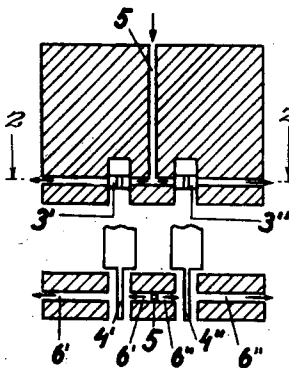
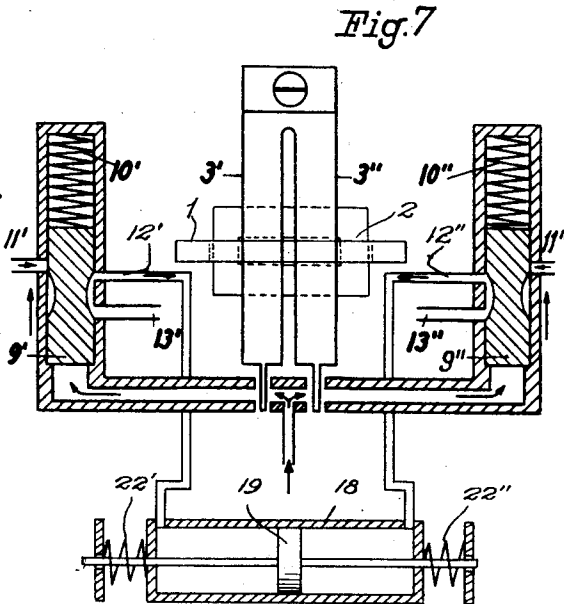


Fig.5



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Fig. 8

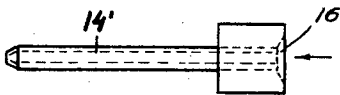


Fig. 9

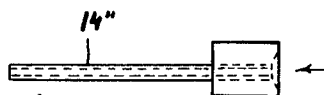


Fig. 8^a



Fig. 9^a



Fig. 10

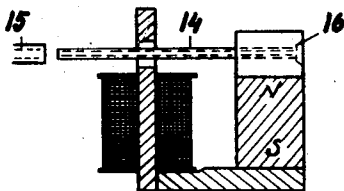
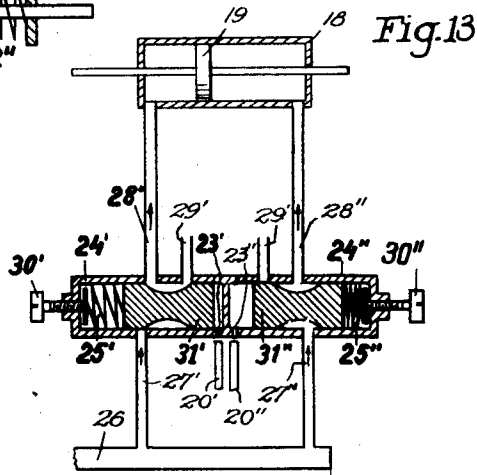
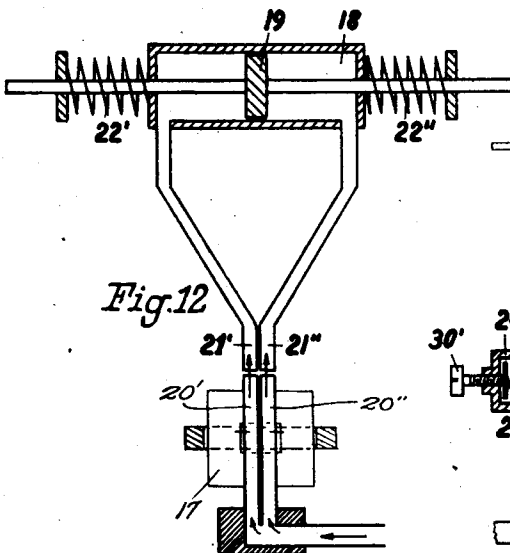
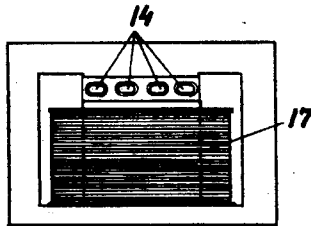


Fig. 11



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Modulator

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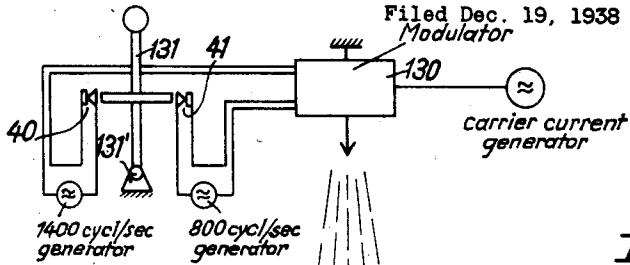


Fig. 15

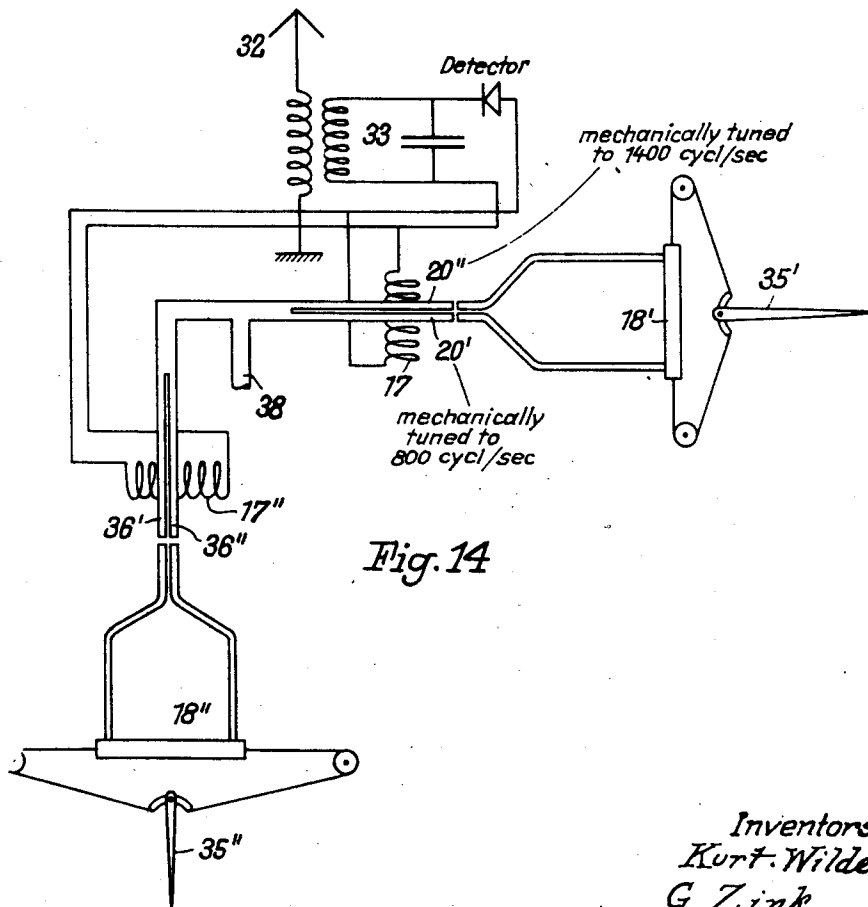
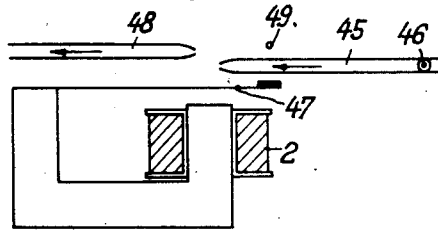


Fig. 14

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UNITED STATES PATENT OFFICE

2,269,072

CONTROLLING DEVICE

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Application December 19, 1938, Serial No. 246,718
In Germany December 12, 1936

7 Claims. (Cl. 121—38)

The present invention relates to a controlling device, as for instance a pressure relay, for converting vibrations, for instance electric oscillations, into pressure impulses. According to the invention, this is achieved by constructing the relay member controlling the pressure fluid flow as a vibrating armature of a resonance relay in such a manner that the vibrating armature, which is set into oscillation, influences the quantity of the pressure fluid flow. Such a relay may be used, for instance, as a controlling device for a remote controlled craft in order to create, by means of electric radiation of certain frequency, a magnetic field, fluctuating in rhythm with the created frequencies, in the magnet coil of the resonance relay. The field sets the relay armature into mechanical resonance vibrations and the periodic fluctuations of a pressure fluid supply then influences a controlling member on the remote controlled craft.

By the remote transmission of a certain number of intermittent controlling impulses, the controlling movement may be remotely transmitted in accordance with the size and direction. Of course, a plurality of vibrating armatures tuned to different frequencies may be provided, whereby each armature is set to oscillate by a certain controlling frequency and each has a certain controlling task. As is well-known in mechanical resonance relays several vibrating armatures, tuned to different frequencies, may cooperate with a single electro-magnetic coil, which is excited simultaneously by currents of different frequency superposed on one another of different frequency.

With reference to the accompanying drawings the subject matter of the invention is more fully explained by means of several embodiments.

Fig. 1 is a vertical sectional view showing an electric-mechanical resonance relay forming part of the pressure fluid relay according to the invention;

Fig. 2 is a front elevation of the relay shown in Fig. 1;

Fig. 3 is a perspective view on enlarged scale of a part of the pressure fluid relay according to the invention;

Fig. 4 is a vertical sectional view of a further detail of a pressure fluid relay according to the invention;

Fig. 5 is a horizontal sectional view taken on the line 2—2 of Fig. 4;

Fig. 6 is a perspective view of a detail;

Fig. 7 is a view partly in section of a plurality

of pressure fluid relays for controlling a pressure fluid operated servo-motor;

Figs. 8 and 9 are side elevations of two modifications of a part of a pressure fluid relay according to the invention;

Figs. 8a and 9a are end views of the jet pipes of Figs. 8 and 9 respectively;

Fig. 10 is a part sectional and part side elevation of the complete pressure fluid relay;

Fig. 11 is a front end view of a plurality of pressure fluid relays as illustrated in Fig. 10;

Fig. 12 is a part sectional and part diagrammatic view of a modification of the arrangement according to Fig. 7;

Fig. 13 is a sectional view of another modification of the arrangement according to Fig. 7;

Fig. 14 is a wiring diagram of a remote-control device in which pressure fluid relays are used at the receiving station according to the invention;

Fig. 15 is a side elevation of another modification of the pressure fluid relay according to the invention.

Fig. 1 shows a section of a resonance relay of the polarized type known per se, the coil 2, having an iron core 2', of which magnetizes the yoke 1 in rhythm with the alternating currents flowing through the coil as indicated in Fig. 2 by broken lines. Between the core 2' and the yoke 1 is an air gap, in which an alternating magnetic field is built up in which the front end of a resilient armature 3 is arranged. The rear end of the armature is mounted on one end of a permanent magnet 51, the other end of which is connected to a soft iron plate 52 upon which is mounted the magnetic core 2'. Therefore, in the core 2' of the coil 2 a permanent field, excited by the magnet 51, is superposed to the alternating magnetic field generated by the coil 2. Thus, a mechanically tuned armature 3 is provided in the resulting magnetic field of the air gap whose free end vibrates under the influence of the exciting field in the plane of the drawing.

Fig. 2 illustrates two vibrating armatures 3' and 3'', which should be tuned to frequencies different from one another. Only one single exciting coil 2 is provided for both vibrating armatures, so that this coil is excited by superposed vibrations of different frequency.

Fig. 3 shows a single vibrating armature 3, having a tongue 4.

Figs. 4 and 5 illustrate a relay in which the pressure fluid is directed transverse to the vibrating plane of the vibrating armatures in an arrangement having two vibrating armatures,

The pressure medium is conveyed through the conduit 5, and branches off into two conduits 6', 6'' which are closed by means of the tongues 4', respectively 4'', in the position of rest of the vibrating armature. If one of the vibrating armatures 3', 3'' begins to oscillate such vibrating armature opens the nozzle of the conduit 6', respectively 6'', thereby permitting the pressure fluid to flow through the conduit 6', respectively 6'' which is unobstructed in accordance with the deflection of the vibrating armature. The vibrating armature thus actuates the corresponding controlling member. Therefore, the vibrating armature, whose mechanical natural vibration corresponds to the arriving controlling frequency, will always be actuated and will open the corresponding pressure fluid conduit.

Fig. 6 shows another modification of the vibrating armature. In this embodiment the tongue 7 of the armature has two knife edges 8' and 8''. Thus on the one hand it is intended to achieve a cutting of the fluid as soon as the tongue is between the nozzles and on the other hand the above described form of the tongue decreases the vortexes in the discharge of the pressure fluid during the vibrating step.

Fig. 7 shows two vibrating armatures 3', 3'' with two auxiliary valves 9', 9'' movable in a dampened manner, which are controlled by the relay impulses of which each controls one amplified pressure fluid stream. As soon as one of the two vibrating armatures begins to oscillate the corresponding auxiliary valve is moved in the direction of the arrow, whereby the corresponding dampening spring 10', respectively 10'', is pressed together. The feeding conduit 11', respectively 11'' for the fluid, under higher pressure, is connected with the discharge conduit 12', respectively 12''. The pressure fluid bypassed through the pipes 12', respectively 12'' then influences the controlling member. Due to its damping the auxiliary valves 9', respectively 9'' do not vibrate in accordance with the fluctuations of the pressure fluid stream by being directly controlled by the vibrating armatures, but they rather remain stationary in the raised position until the vibration of the vibrating armature has ceased. As soon as this takes place, the conduits 12', respectively 12'', are connected with the conduits 13', respectively 13'', so that the fluid which is under pressure in the conduits 12', 12'' may flow off through the conduits 13', 13''.

The apparatus may be constructed in such manner that on one piston side each of a double-acting servo-motor 18 a pressure fluid stream, controlled by a special vibrating armature, is effective, whereby both vibrating armatures are synchronized to frequencies different from one another. In accordance with the exciting of the one or the other vibrating armature 3', 3'' and in accordance with the duration of the excitation, the servo-motor piston 19 is displaced to a certain degree out of its original middle position in the one or the other direction. In order to again return the piston into its original position after the termination of the exciting of the vibrating armature, the piston may be provided with restoring springs 22', 22'', the piston moving in opposition to their forces. In this manner the rudder or elevator control of a remotely controlled aircraft may be adjusted. Thus it is possible to remotely control the craft by means of a slight force.

The use of force magnifying means also has the special advantage that the pressure fluid

stream directed transverse to the direction of vibration of the vibrating armature can be maintained so slight that it can not set the vibrating armatures into oscillation due to vortex formation.

If the vibrating armatures do not entirely shut off the pressure fluid stream in the position of rest, this may further be achieved by proportioning the damping springs 10', 10'' in such a way that the auxiliary pistons cannot be raised so far until the pressure fluid channels 11' and 12'' are connected with one another. It may also be achieved by means of the damping springs that irregularities in the quantity of pressure fluid delivered by the relay due to deviations of the direction of vibration from the desired direction, have no influence on the member to be controlled. In order to more easily adapt the damping of the auxiliary valves to the existing conditions the damping springs 10', respectively 10'', of the auxiliary valves may be adjustable, for instance by means of adjusting screws as shown in Fig. 13 by 30', 30''.

Figs. 8 and 9 show the control of the pressure fluid stream by means of a vibrating jet-pipe. According to Fig. 8, the jet-pipe 14' preferably of steel has a circular cross-section, whilst the jet-pipe 14'' according to Fig. 9 has an oval cross-section, the greatest diameter of which lies transversely to the direction of vibration. Thus an exactly defined direction of vibration may be achieved.

Fig. 10 illustrates the jet-pipe vibrating in front of the reception nozzle 15, together with the remaining relay member, known per se, which is similar in its construction to the type illustrated in Fig. 1 or 2.

The controlling pressure fluid is fed to the jet-pipe 14 through the opening 16. The rearward end of the jet-pipe is held by a block 53 which is mounted on the permanent magnet 51. Fig. 11 shows four jet-pipes 14 cooperating with one single relay coil 17. The different controlling frequencies are fed to this coil, each setting one single jet-pipe into oscillation, to cause a corresponding controlling step. In an arrangement according to Fig. 11 the four jet-pipes can operate in pairs, that is one servo-motor for each pair, so that for example two jet-pipes displace the rudder control and two jet-pipes the elevator control of a craft.

Fig. 12 shows a double-acting piston servo-motor 18 with a piston 19 which is controlled by two pressure fluid streams, each acting upon one side thereof. The pressure fluid streams are delivered by a special vibrating armature in the manner of a jet-pipe 20', 20'', of which each reacts to a certain controlling frequency. In their position of rest both jet-pipes are in front of the reception nozzles 21', 21'', thus being directly opposite to them. In the position of rest of the two jet-pipes the piston 19 is, therefore, in the middle position. If one of the two jet-pipes is set into oscillation by a controlling frequency, then the pressure of the pressure fluid delivered by the other jet-pipe predominates so that the servo-motor piston and, therefore, the controlling member influenced by this piston correspondingly adjust themselves. If the controlling vibration ceases, the piston 19 is again restored to its middle position by the force of the restoring springs 22', respectively 22''.

Fig. 13 shows two auxiliary valves for the magnification of the impulse delivered by the jet-

pipe. Each of the two jet-pipes is movable in front of an opening 23', respectively 23'' of the valve casing 24', respectively 24'', in which one of the auxiliary valves 31', 31'' may move under the influence of a pressure fluid impulse in opposition to the tension of a damping spring 25', respectively 25''. By means of the damping springs the result is attained in that the auxiliary valves do not react to every vibration of the jet-pipe, but are only moved back and forth in accordance with the number and duration of the controlling impulse comprising several controlling vibrations. In the position of rest of the two jet-pipes, in which these are directly opposed to the reception nozzles the two auxiliary valves are in their end position and connect the pipes 27', respectively 27'', branching off from the common pressure fluid feeding conduit 26 with the discharge conduits 28', 28'', which conduct the pressure fluid to both sides of the servo-motor piston 19. If one jet-pipe, e. g. the one movable in front of the opening 23', is set into oscillation, then the pressure acting on the auxiliary piston 31' diminishes, and, as a result thereof, this auxiliary piston near its right end position thereby closes the pressure fluid conduit 27', whilst at the same time the conduit 28' is connected to the discharge 29'. The operation is illustrated in Fig. 13. In view thereof the pressure of the pressure fluid conduit 27', respectively 28'', acting on one piston side predominates, whilst the pressure fluid acting on the other piston side flows off through the conduit 29', so that as a result the servo-motor piston is moved out of its middle position and the controlling member is correspondingly deflected after the termination of the impulse control. Thus jet-pipe is again in front of the conduit 23', i. e. the auxiliary piston 31' again returns to its left end position, whereby the conduits 27' and 28' are again connected with one another.

In this arrangement the use of auxiliary valves movable in a damped manner still has a favourable effect in that unequal positions of both vibrating armatures in the position of rest, which could already cause a displacement of the servo-motor piston, can be compensated by proportioning the damping spring forces of the auxiliary valves.

By means of adjusting screws 30', 30'' the tension of the damping springs can be changed and adapted to the existing conditions.

The before described pressure fluid relay may be especially used in combination with a device for remotely controlling a plurality of apparatus at a receiving station. Such an arrangement comprises a transmitter for sending out electrical signals of different tone frequencies and at the receiving station mechanical resonance relays with armatures, each of which is mechanically tuned to a certain tone frequency to be set into oscillation under the influence of said frequency; said armatures controlling different pressure fluid streams for adjusting the apparatus.

Such apparatus to be remotely controlled may be, for instance the rudder and elevator control of an aircraft.

The remote control, for instance the rudder and elevator control, of an aircraft may be effected in the following manner:

The transmitter sends out different tone frequencies, each frequency having a certain controlling task, whereby the tone frequencies may

be superposed on a carrier wave of high frequency. Said frequencies are transmitted to the exciting coil of the resonance relays which in this case are built into the aircraft, the apparatus to be controlled being the rudder and elevator control of the aircraft.

Fig. 14 shows diagrammatically such an arrangement. 130 is a high frequency transmitter, the carrier wave of which can be modulated by tone frequencies. The superposition of the tone frequency is controlled by a lever 131 which is pivoted at 131' and may be swung in every direction round its pivot point 131'. If the lever is swung to the right or to the left, the switch 40 or 41 is closed, thereby modulating the carrier wave by a tone frequency, for instance 800 cycles/sec. or another one for instance 1400 cycles/sec. respectively. The modulated carrier wave is received by the antenna 32 of the aircraft, the course of which is to be remotely controlled. The receiving circuit 33 on board of the aircraft is tuned to the carrier wave. 17 is a coil of a resonance relay being fed by electrical impulses of tone frequency and having two vibrating jet-pipes 20', 20'' as illustrated in Fig. 12, one of which (20') being mechanically tuned to 800 cycles/sec. whilst the other is tuned to 1400 cycles/sec. 18' is the servo-motor, the piston of which acts in the usual manner upon a rudder 35'. 38 is the pressure fluid feeding conduit. In accordance with the exciting of the coil 17' by the one or the other controlling frequency the piston of the servo-motor 18' and therewith the rudder 35' is alternatively moved to the right or the left.

For elevator control of the aircraft the lever 131 is movable in a direction perpendicular to the before mentioned direction, thereby closing one of two other contacts (not shown). In this manner, two other different tone frequencies may be alternatively superposed on the carrier wave. A second resonance relay is provided having a coil 17'' and two other jet-pipes 36', 36'' acting as vibrating armatures and each being tuned to one of these two controlling frequencies. A second servo-motor 18'' is provided which adjusts the position of the elevator 35''.

These resonance relays act as mechanical synchronizing means for the controlling frequencies, as each vibrating armature reacts to only one frequency. Therefore, only mechanical filtering means are needed to separate the tone frequencies, said filtering means simultaneously controlling, according to the invention, the pressure fluid stream. Thus the use of tone frequencies has the advantage that the remote control is simplified, as well at the transmitting station as at the receiving station.

A further and essential advantage is that at the receiving station there are no electrical contacts for actuating the servo-motors.

Other changes and modifications of the structures shown and rearrangements of parts, will now be apparent to those skilled in the art and may be made without departing from the scope of the invention.

Thus the vibrating armature need not directly control the pressure fluid, but this control may take place indirectly. This may be achieved according to Fig. 15 by movably mounting a member, directly controlling the pressure fluid stream, for instance a jet-pipe 45 rotatably mounted around the pivot 46, and being in an engaging relation with the vibrating armature 47 mechani-

cally tuned to a certain tone frequency in such a manner that as soon as and so long as the vibrating armature 47 oscillates, it varies the position of the movable member 45. The movements of this member must be damped so that it does not execute all movements of the armature as described with respect to the auxiliary valve of Figs. 7 and 13. If the jet-pipe is moved out of its rest position, the pressure fluid delivered by the jet-pipe enters the reception nozzle 48. 49 is a stop for limiting the movement of the jet-pipe 45.

Reference will therefore be had to the appended claims for a definition of the limits of said invention.

We claim:

1. A pressure fluid relay comprising in combination a mechanical resonance relay having a resilient armature which is mechanically tuned to a controlling frequency and which is adapted to be set into vibration under the influence of said frequency; and means for directing a pressure fluid stream and a pressure fluid valve controlling the intensity of said pressure fluid stream, said valve being in direct operative connection with said armature for varying the intensity of said pressure fluid stream upon vibration of the armature.

2. A pressure fluid relay comprising in combination a mechanical resonance relay having a resilient armature which is mechanically tuned to a controlling frequency and which is adapted to be set into vibration under the influence of said frequency; and means for directing a pressure fluid stream, said armature being constructed as a pressure fluid valve for periodically varying, in its state of vibration the intensity of the pressure fluid stream.

3. A pressure fluid relay comprising in combination an exciting coil adapted to be excited by controlling electric impulses of sound frequency; a resilient armature cooperating with said coil and being mechanically tuned to the frequency of the controlling impulses which are to be set into vibration under the influence of said controlling impulses; means for directing a pressure fluid stream; and a pressure fluid valve controlling the intensity of said pressure fluid stream, said valve being in direct operative connection with said armature for varying the intensity of said pressure fluid stream upon vibration of said armature.

4. A pressure fluid relay comprising in com-

5 bination a single exciting coil adapted to be excited by a plurality of controlling electric impulses of different sound frequency; a plurality of resilient armatures each cooperating with said coil and being tuned to a certain frequency of said controlling impulses which are to be set into vibration under the influence of a certain controlling frequency; means for directing a plurality of pressure fluid streams; and pressure fluid valves, each valve controlling the intensity of a pressure fluid stream and being in direct operative connection with an armature of which each of the latter varies the intensity of one of said pressure fluid streams upon vibration of the respective armature.

5. A pressure fluid relay comprising, in combination, a mechanical resonance relay having a resilient armature which is mechanically tuned to a controlling frequency to be set into vibration under the influence of said frequency; and means for directing a pressure fluid stream including nozzles for feeding and receiving the pressure fluid stream which are arranged transverse to the plane in which said armature vibrates, the nozzles being coaxially arranged and said armature having a knife edge for periodically interrupting said pressure fluid stream.

6. A pressure fluid relay comprising, in combination, a mechanical resonance relay having a resilient armature to be set into vibration under the influence of a controlling frequency; means for directing a pressure fluid stream, said armature being formed as a vibratory jet pipe to which the pressure fluid is directed; and a nozzle provided in front of the nozzle of said jet pipe for receiving the periodically interrupted pressure fluid stream leaving the jet pipe nozzle.

7. A pressure fluid relay comprising, in combination, a mechanical resonance relay having a resilient armature to be set into vibration under the influence of a controlling frequency; means for directing a pressure fluid stream, said armature being formed as a vibratory jet pipe which is fed by the pressure fluid stream; and a nozzle provided in front of the nozzle of said jet pipe for receiving the periodically interrupted pressure fluid stream leaving the jet pipe nozzle, said jet pipe nozzle having an oval opening the greatest diameter of which lies transversely to the direction of vibration of said jet pipe.

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