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R. BECHMANN ET AL  
PIEZOELECTRIC CRYSTAL HOLDER

2,270,922

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2 Sheets-Sheet 1

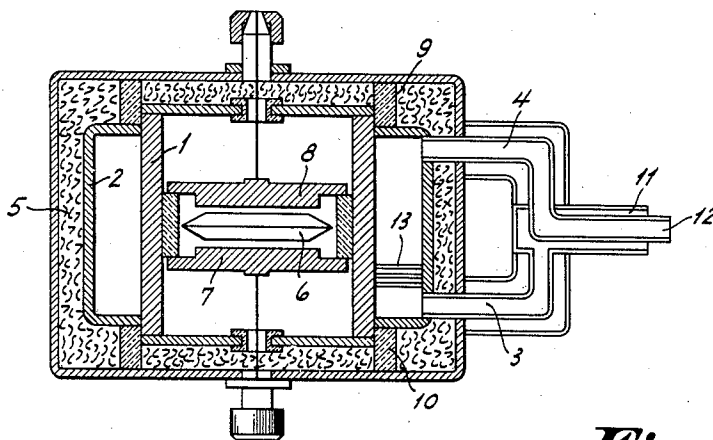


*Fig. 1*

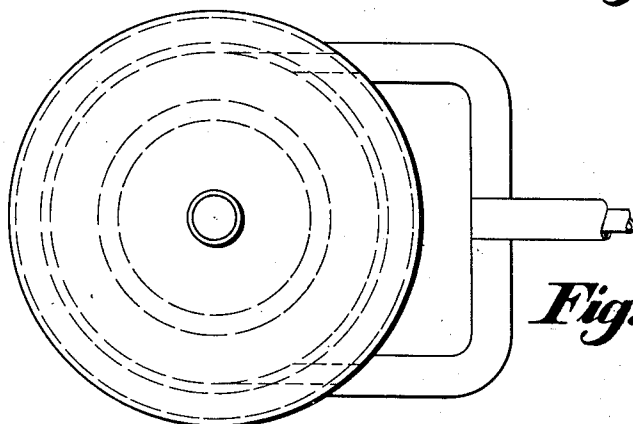


*Fig. 1a.*

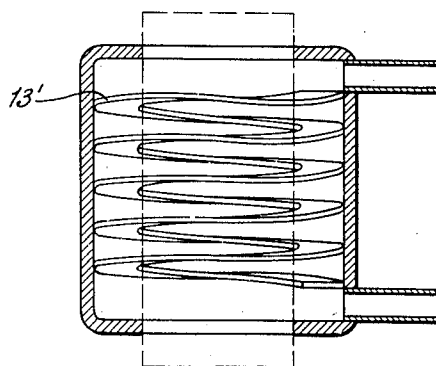


*Fig. 2*

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2 Sheets-Sheet 2

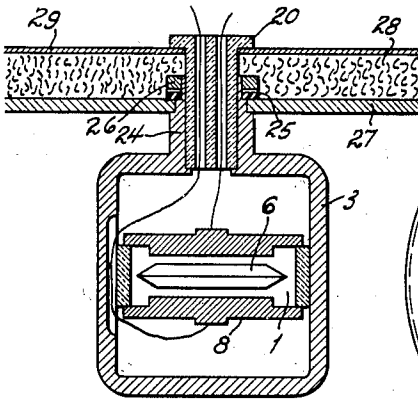


*Fig. 3*

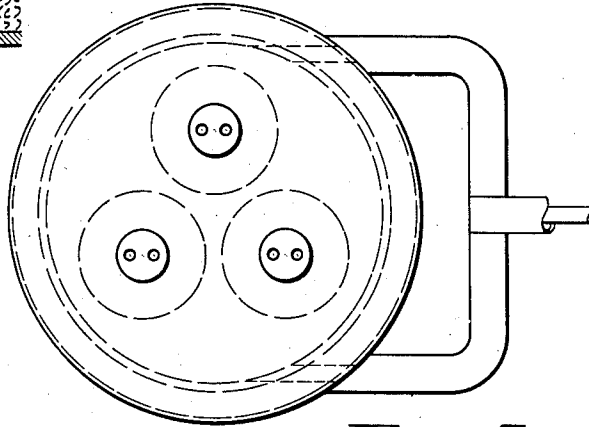


*Fig. 5*

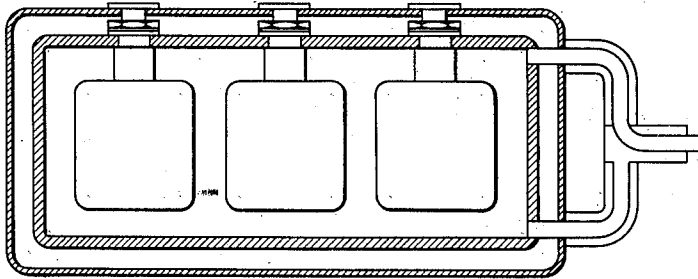


*Fig. 4*

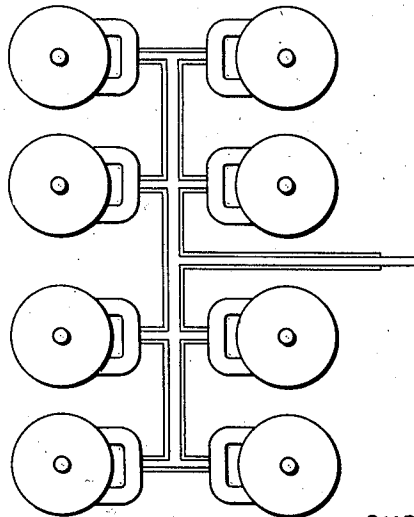


*Fig. 6*

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## UNITED STATES PATENT OFFICE

2,270,922

## PIEZOELECTRIC CRYSTAL HOLDER

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Application October 17, 1939, Serial No. 299,792  
In Germany September 12, 1938

7 Claims. (Cl. 171—327)

This invention relates to a new and useful mounting or holder for piezo-electric oscillators and resonators. An object of this invention is to improve the temperature stability of a quartz crystal holder.

A feature of this invention is the arrangement of circulating a fluid around the crystal to maintain a substantially constant temperature thereto.

Even when quartz crystals having low temperature coefficients are used, the question of temperature stabilization of the quartz crystal is important and in many cases it is necessary to insure great constancy or stability of piezo-electric oscillators and resonators. In the operation of a plurality of broadcast stations on one and the same wave length or in the construction of quartz clocks or time pieces, the frequency stability must be of an order of magnitude of  $10^{-8}$  or over. Using quartz crystals having a temperature coefficient of  $1 \times 10^{-7}$ , the temperature constancy must be one-tenth of one degree C., while in extreme cases the temperature constancy must be up to one-hundredth of one degree C.

It is a known fact that thermostats operated by heater elements in an air ambient will insure temperature stability of over one-tenth of one degree only with relatively elaborate circuit means. Thermostats which are predicated upon liquids for their operation are far less involved and difficult in practical use. It is known that liquid baths which are agitated by stirring means can be kept at a constant value without any great difficulty up to one-hundredth of one degree C. In fact, by the use of liquid thermostats of this kind, it is possible to establish stable states of temperature in air spaces in which elements to be maintained at a constant temperature are immersed. One shortcoming of all temperature regulator or thermostatic devices which are in the form of heat containers is that they require considerable time for heating up because the temperature balance or equalization between the enclosure or chamber which is to be kept at a constant temperature by the heater elements and the means to be regulated or controlled is effected by the circulation of air.

According to the invention, the quartz mounting or holder is to be kept at a stable temperature by the use of a circulating liquid thermo-device which is directly built in the form of a liquid thermostat in such a way that the wall or shell of the quartz crystal mounting directly forms the water container or chamber or else the mounting is hermetically sealed and is immersed

inside a liquid bath which is kept at a constant temperature.

This invention will best be understood by referring to the accompanying drawings, in which:

Fig. 1 is a cross-sectional view of a single crystal holder;

Fig. 1a is a plan view of Fig. 1;

Fig. 2 is a sectional view of another embodiment of this invention;

Fig. 3 is a sectional view of a crystal disposed within a hermetically sealed vessel;

Fig. 4 is a sectional view of a combination of several crystal mountings;

Fig. 5 is a plan view of Fig. 4; and

Fig. 6 is a plan view of a holder for retaining eight crystals which are disposed in parallel and in series arrangement.

An exemplified embodiment of a quartz crystal mounting which is maintained directly at a constant temperature by a current of water is shown in Fig. 1. The quartz crystal mounting properly so-called is indicated at 1 and contains a liquid chamber 2 through which the liquid may be maintained at a stabilized temperature by being circulated by means of a pump from any suitable source, the liquid being passed through the orifices 3 and 4. To insure better safety against thermal radiation, a heat-insulating coat 5 is placed around the mounting. The crystal and the electrode system co-operating therewith are disposed in the interior of the metallic cylinder 1, the crystal being denoted by 6 and the two electrodes by 7 and 8. 9 and 10 are insulation disks designed to preclude the danger of unnecessary chilling of the electrode system from the outside. In order to prevent undue cooling of the liquid flowing through the admission ducts and kept at a constant temperature, the inlet and outlet ducts are disposed concentrically or co-axially in accordance with the counter-flow principle as indicated at 11 and 12. 11 and 12 indicate the inlet and outlet pipes or ducts as being arranged inside each other, so that there is a chance for the temperature difference in the inlet and outlet pipes to become equalized. In order to promote flow of water under conditions of thorough contact, the two inlet and outlet tubes 3 and 4 are arranged tangentially in respect to the shell of the water container or chamber. As a result, the water influx will be tangentially in relation to the water chamber. In order that the water circulation may be uniform and regular, no matter what the particular position of the mounting illustrated in Fig. 1, a rib or fin system 13 is provided in the water

chamber 2 designed to impart to the water a desirable "twist." A more detailed and special arrangement of the said rib or fin system is shown in Fig. 2 wherein there is shown a thin flat strip 13' arranged to form a spiral path which surrounds the outside wall of the crystal mounting. The ends of the strip terminate adjacent the inlet and outlet tubes.

Another exemplified embodiment of the liquid thermostat is shown in Fig. 3. The crystal mounting 1 with the crystal 6 is disposed inside a hermetically sealed vessel 23. The latter is arranged to have all around contact with the flow of liquid, the latter being kept at a stable temperature. The body or vessel 23 is suspended by means of a neck 24 in the double-walled cover (27, 28 and 29). The connection between the cover and the vessel preferably consists of a ceramic pipe 20 which has poor heat conducting properties. The said ceramic pipe piece moreover contains the two electrode leads brought to the crystal. The body 24 is secured on the double-wall 7, for instance, by the aid of a rubber packing 25 and a screw joint 26.

The thermal contact or union between the quartz crystal and the mounting of the crystal, itself, in an embodiment as shown in Figs. 1 and 3, should be as perfect and thorough as possible. In this manner, the heating-up period of the thermostat will be fast, as the supply of heat is not by virtue of air convection, but rather by heat conduction by way of the metallic material. In the embodiment just described, this will be accomplishable by having the wall of the mounting of the crystal, itself, maintained, at a constant temperature because of the constant temperature of the circulating liquid. Contradistinct to air thermostats delay or baffle elements designed to compensate and equalize the temperature for the heat conduction are undesirable.

Fig. 4 shows a combination of several quartz crystal mountings of the kind shown in Fig. 3 inside a double-walled or jacketed liquid container or chamber. The liquid is suitably admitted in the same way as in Fig. 3.

Fig. 5 shows a plan view of such an arrangement, with the trough being in the form of a jacketed cylinder.

Mounting of the kind described by reference to Fig. 1 according to this invention may be assembled and combined in any desired number by arranging the liquid supply means in parallel or in series. Fig. 6 shows an exemplified embodiment in which eight quartz crystals are connected with one and the same admission and supply system. In the scheme shown in Fig. 6, pairs of crystal mountings are disposed in parallel and in series. For the sake of facilitating exchange of units recourse is had to screw union which is adapted to be speedily opened.

What is claimed is:

1. A piezo-electric crystal holder comprising a crystal located within a casing, an inner wall for said casing which surrounds the crystal, a rib system arranged outside said inner wall, a circulating fluid path formed by said rib system which surrounds the crystal and having its path in contact with the inner wall of said casing, and an inlet and an outlet at substantially the same point on the outside wall of said casing.

2. A piezo-electric crystal holder comprising a

plurality of crystals located within a casing, an inner wall surrounding each of said crystals within the casing, a rib system arranged outside said inner wall, a circulating fluid path formed by said rib system which surrounds the crystals and having its path in contact with the inner wall of said casing, and an inlet and an outlet coaxially arranged at the same point on the outside wall of said casing.

3. A piezo-electric crystal holder comprising a crystal located within a casing, an inner wall for said casing which surrounds the crystal, a rib system arranged outside said inner wall, a circulating fluid path formed by said rib system to impart a twist to said fluid which surrounds the crystal and having its path in contact with the inner wall of said casing, and an inlet and an outlet at substantially the same point on the outside wall of said casing.

4. A piezo-electric crystal holder comprising a crystal located within a casing, an inner wall for said casing which surrounds the crystal, a rib system comprising a flat strip arranged to form a spiral path around the outside of said inner wall, a circulating fluid path formed by said rib system which surrounds the crystal and having its path in contact with the inner wall of said casing, an inlet and an outlet coaxially arranged at the same point on the outside wall of said casing and located tangential with respect to said fluid path.

5. A piezo-electric crystal holder comprising a plurality of crystals, a double-walled metallic casing for enclosing and maintaining a constant temperature on said crystals, a vessel surrounding each one of said crystals, each one of said vessels supported by one of the double walls of said casing, a circulating fluid surrounding said vessels and having its path in contact with the inner wall of said casing and the outer walls of said vessels, an inlet and outlet for said circulating fluid located substantially at the same point on the outside wall of said casing.

6. A piezo-electric crystal holder comprising a plurality of crystals, a double-walled metallic casing for enclosing and maintaining a constant temperature on said crystals, a vessel surrounding each one of said crystals, each one of said vessels supported by one of the double walls of said casing, a circulating fluid surrounding said vessels and having its path in contact with the inner wall of said casing and the outer walls of said vessels, and an inlet and outlet for said circulating fluid coaxially arranged at substantially the same point on the outside wall of said casing.

7. A piezo-electric crystal holder comprising a crystal, a double walled metallic casing for enclosing and maintaining a constant temperature for said crystal, a hermetically sealed vessel having a neck portion for enclosing said crystal, said hermetically sealed vessel supported by one of the double walls of said casing at its neck portion, a circulating fluid surrounding said hermetically sealed vessel and having its path in contact with the inner wall of said casing and the outer wall of said vessel, and an inlet and outlet for said circulating fluid located at the same point on the outside wall of said casing.

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