June 29, 1948. W. C. HASSELHORN 2,444,198

HERMETICALLY SEALED ELECTROMAGNETIC RELAY

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Fig. 1.

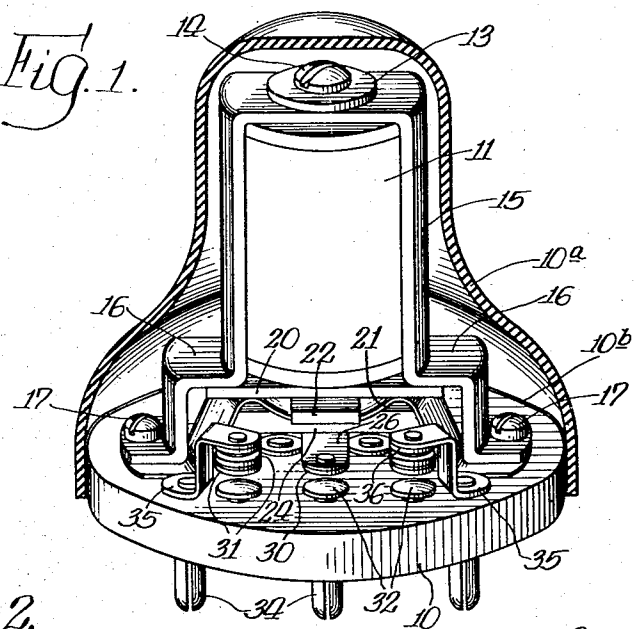


Fig. 2.

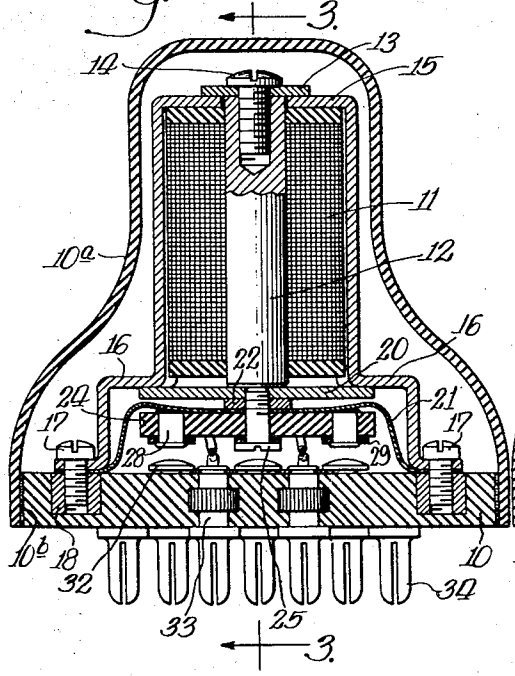
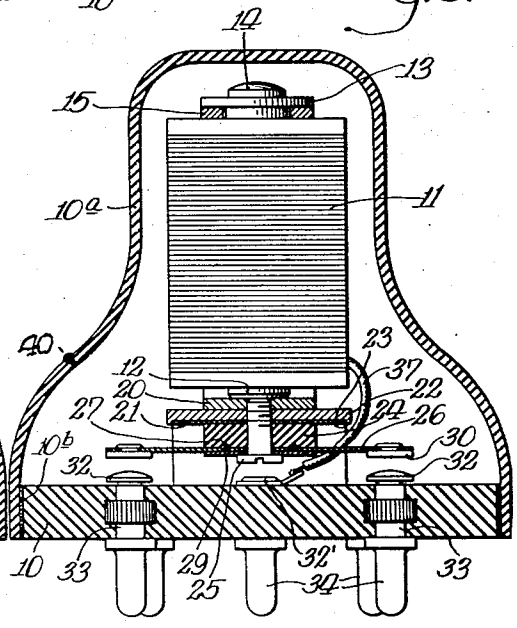


Fig. 3.



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Fig. 4.

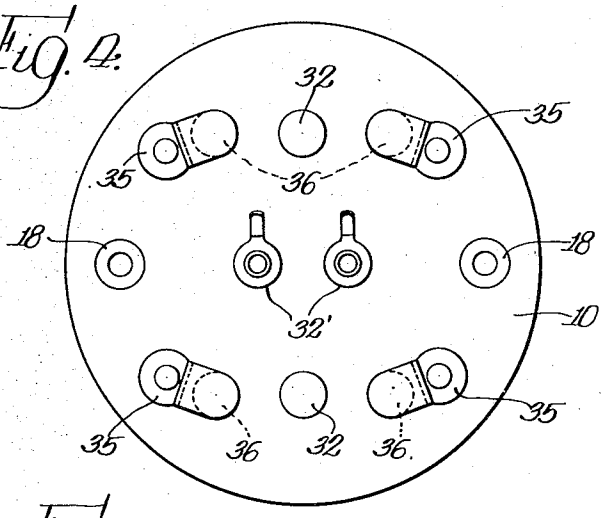


Fig. 5.

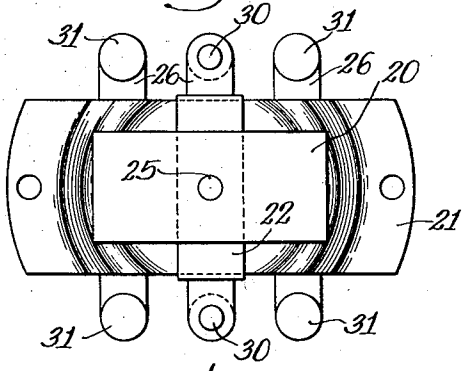


Fig. 8.

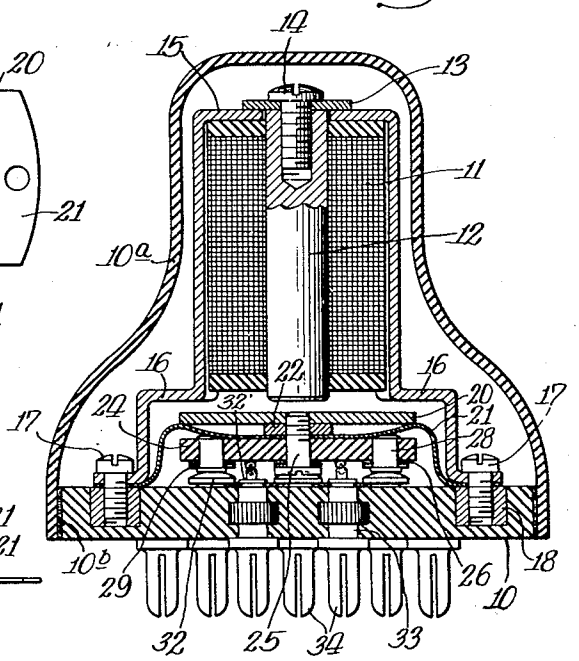


Fig. 6.

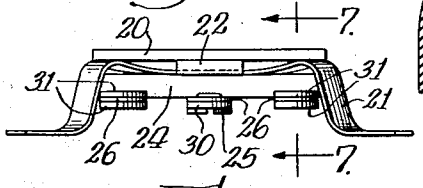
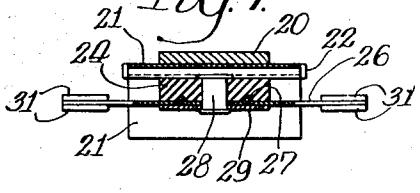


Fig. 7.



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UNITED STATES PATENT OFFICE

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HERMETICALLY SEALED ELECTRO-MAGNETIC RELAY

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Application April 1, 1944, Serial No. 529,211

5 Claims. (Cl. 200—87)

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This invention relates to relays and has for one of its objects the provision of a relay which can be used to operate at high altitudes or below sea level, in dust or moisture, in corrosive films or combustible gases, with full reliability and efficiency.

The invention is particularly directed to an improved construction of relay that is capable of operating under practically all conditions of use. Control devices relying upon relays for their operation are limited in their performance by the ability of their relays to function. Failure of the relays will result in failure of the control devices, and consequently the failure of certain operations. These failures often become serious and impede the progress of developments that could otherwise be made. It is well known that relay failures have caused many fatal accidents and have been the deciding factor in abandoning many projects that would have otherwise been successful.

In an effort to overcome the difficulties heretofore experienced, the present invention is designed to provide an improved construction of relay that can be made to operate practically under any and all predetermined operating conditions and to assure successful performance even to the extent of preventing corrosion of the parts, sparking at the contacts or failure due to vibration. Moreover, the effects of abrasive dust or combustible fumes are completely eliminated and detrimental conditions of operation due to extreme changes in atmospheric pressure are overcome.

It will be understood that the invention is directed particularly in the discovery of a simple structure that solves the many problems that were heretofore encountered in the operation of a relay and assures performance under all known conditions of use.

Specifically, the invention is to provide a relay capable of operating under the peculiar conditions of extremely high altitudes directly from sea level pressures, unusual moisture conditions and in places where destructive abrasive dust, corrosive fumes or explosive gases exist. Moreover, the structure provides for sealing out moist air and for the use of inert gases to eliminate arcing. I have also found that the structure will not be affected by vibration, shock or sudden jarring, and that, in this connection, it may be provided with simple means effecting a quick make and break of the contacts either upon energization or de-energization, or both, of the relay so as to eliminate a tendency of the contacts to arc and a consequent destruction over a period of time.

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Another important object of the invention resides in the provision of a relay arranged in the form of a unitary assembly that may be readily connected in the circuit, or replaced in the circuit, without requiring the disconnecting of wires or the resoldering of them to the contact springs, the unitary assembly including as a feature an enclosure which houses the relay and contact springs, if so desired, and which may be transparent to permit inspection of the wiring connections, although sealed in and not accessible without destroying the seal. Thus, as a unitary assembly, the relay may be readily inserted in the circuit, it being advantageous to use plug contacts protruding from the base so that the easy connectibility of the unit may be accomplished by merely plugging in these plug contacts to the socket provided therefor in the circuit.

A further object of the invention is the provision of a relay having an armature carried by an over-center spring and switch contacts operated thereby whereby said switch contacts are caused by said spring under the influence of said relay to operate in one or both directions by a snap action to effect a quick make and break and to prevent vibration or shock from affecting the operation thereof.

Still further objects and advantages will appear from the detailed description and claims to follow, in connection with the accompanying drawing, in which the same reference characters designate the same parts throughout, and in which—

Fig. 1 is a perspective elevational view of the relay, with the front half of the sealing casing removed;

Fig. 2 is a central vertical section through the complete device on a plane parallel to the plane of vision of Fig. 1, and illustrating the position of the parts when the relay is energized;

Fig. 3 is a section similar to that of Fig. 2, but at right angles thereto, and the magnet coil not being sectioned;

Fig. 4 is a bottom plan view of the base of the relay, the other parts being removed to show the location of the electrical contacts and connections;

Fig. 5 is a plan view of the relay armature and supporting over-center spring;

Fig. 6 is a side view or elevation of same;

Fig. 7 is a cross-section on the line 7—7 of Fig. 6; and

Fig. 8 is a view similar to Fig. 2, but with the parts in their position when the relay is de-energized.

The relay comprises a base 10 of suitable material of high insulating and dielectric quality, such as Lucite, tenite, Bakelite, glass, porcelain, etc., and preferably such as to admit the molding of parts therein, such as binding posts or the like, metal anchorages for screws, etc. The assembly is mounted on one side of this base, the electric connections to the outside being by posts passing through the base and preferably molded and hermetically sealed therein. A cover 10*a* of suitable material, such as metal, glass, plastics, etc., is placed over the relay assembly and suitably and hermetically sealed to the base at the edge 10*b* which closely fits the periphery of the base 10. The cover or casing may be of any form desired but preferably is circular in cross-section and is reduced in diameter toward the upper part, nicely to cover and accommodate the relay magnet. The lower edge fits over the edge of the base 10 and is cemented or otherwise hermetically sealed thereto. The result is a hermetically sealed relay which is of great advantage in certain situations, since the preferred operating conditions can be sealed therein and objectionable ones sealed out.

The operating parts or relay assembly include a magnet coil 11 mounted on a suitable core 12, which is secured at its upper end by washer 13 and screw 14 to a supporting frame member 15, the vertical portions thereof extending along the sides of the coil being transversely curved or arced, if so desired, to conform to the curvature of the outside of the coil. The free ends of this member 15 are bent outwardly, as at 16, and then downwardly or toward the base 10, where the ends are again bent outwardly to form feet by which they are secured by screws 17 to the base 10, each screw threading into a metal insert 18 suitably embedded into the material of the base. This firmly secures the frame and magnet to the base.

The frame 15 not only acts as a mechanical support for the coil and core of the magnet, but, like the core, being of magnetic material such as soft iron, it also forms part of the metal magnetic circuit of the magnet and relay. The armature 20, responsive to the energization and de-energization, respectively, of the magnet, closes and opens the said magnetic circuit at the lower end of the magnet between the core 12 and the frame 15. This operation of the armature serves to open and close switch contacts of the relay, which it is desired shall both open and close with a snap action, particularly when, as here, there are both front and back contacts operated by the armature in its forward and back movements, respectively.

To do this the armature 20 is preferably carried by an over-center spring or diaphragm-like spring 21 having the known property of snapping in one direction when pressed beyond its center and snapping back when released. The spring 21 is of this type and of suitable material and of substantially the form indicated in the drawings, with its ends bent downwardly to engage under the feet of the frame 15 and be secured thereby and by the screw 17 to the base 10.

On top of the spring 21 and at the center a spacer 22 between the spring and armature is provided and extends the width of the spring, with end flanges 23 (Fig. 3) extending down over the edges of the spring to keep the parts in position. Beneath the spring a rectangular insulating plate or block 24 is located. This insulator is about the length and width of the armature but on the other side of the spring 21. A screw bolt 25 threads through this insulator 24, the over-center spring 21 and into the metal spacer 22 and armature 20 to secure them all rigidly together at this point.

A purpose of this insulator is to carry the movable switch contacts of the relay, which, in this instance, take the form of bridging spring strips 26 of suitable material secured midway of their length to the under side of the insulator 24 and crosswise thereof and carry suitable switch contacts at their ends. There are three such spring contacts here shown, but of course the number and arrangement may differ. The strips are centrally apertured for the fastening screw or means to secure them to the insulator and are prick-punched, as at 27, to hold them in proper position. The central spring contact 26 is secured in place on the insulator 24 by the screw 25. The two end springs 26 are secured in a similar way to the insulator, but a hollow rivet 28 may be used instead of a screw like 25 for the center fastening, said hollow rivet 28 having its upper head sufficiently spaced from spring 21 to prevent contact therewith. A suitable elongated rectangular spring washer 29 may be put between the head of the center fastening screw or rivet and the spring to strengthen the same.

The ends of these contact springs 26 are provided with switch contact terminals, which at the present time are preferably made of fine silver. They may be in the form of one-sided rivets 30, as on the ends of the central spring contact, which makes contact only on one side of the spring, or with a contact head 31 on both sides, as in the case of the end spring contacts 26 (Figs. 6 and 7).

The contacts on the base 10 which co-operate with the spring contacts thus controlled by the armature and carried by the over-center spring 21 are provided with similar contact heads 32 set into the ends of the plugs or pins 33, which are preferably molded in the material of the base and have contact ends 34 projecting on the outside of the base to receive the outside circuit connections.

The contact heads 32 form the back contacts of the relay. They are closed when the relay is de-energized. The forward or front contacts are supported in proper relative position, as indicated in Fig. 1, by bracket supports 35 suitably secured, as by riveting, to the plug 33 in the base and carrying a contact 36 on the under side of its free end, as shown. The contact 36 stands over and in position to be engaged by an end contact 31 of one of the end contact springs 26 carried by the insulator over-center spring 21 and attached to the armature 20. These contacts 36 are the front or forward contacts of the relay.

Fig. 4 shows the layout of the base 10 which may of course be varied according to the use to which the relay is put. The outer holes in metal inserts 18 are for the screws 17 for securing the relay frame 15 to the base. The terminals 32' nearest the center are connected by wires 37 (Fig. 3) to the relay coil. These terminals 32' have pins or plugs 34 on the outside of the base for circuit connections. The two circles 32 on the vertical diameter, as viewed in Fig. 4, are the back contacts 32 for the middle spring 26 carried by the insulator. This spring 26 bridges these contacts 32 and completes the circuit between them when the magnet or relay is de-energized.

The supporting brackets 35 shown in plan in this Fig. 4 are for engagement by the two end contact springs 26 when the magnet is energized. This arrangement, of course, may be varied as desired, and some of the contacts may be forward

contacts only, or rear contacts only, or both forward and rear.

As stated, the over-center spring 21 is constructed and arranged so that when current is applied to the relay coil it will cause the armature and the contact springs carried thereby to snap to a forward closing position, and when the current is cut off from the coil and the magnetic pull on the armature ceases it will snap to its open position and carry the contact springs with it. Consequently, spring means 21 causes the switch to move with a snap action in both directions.

In operation, the flow of current from the outside through the central plugs 34, the inside terminals 32' and conductors 37 to and through the magnet coil 11 energizes the same and causes the armature 20 to be attracted and moved upwardly. This movement of the armature flexes the over-center spring 21, and, owing to its formation and action, the spring causes the armature to snap forward to complete its forward movement. This has the effect of closing, by snap action, the switch springs carried by the insulator which is affixed to the over-center spring and armature, upon their forward contacts, if any, and bridging same to close the circuits at this point which may be controlled thereby. At the same time, by the same movement the rear or back contacts of the spring strips, if any, are opened and the circuits therethrough broken at such points.

When the magnet 11 is de-energized, the reverse operation takes place. Again, the over-center spring 21 moves the armature and returns with a snap action to break the circuits through the forward contacts of the springs 26 and to close their back contacts.

Both forward and back movements of the switch contacts include the snap action due to the inherent action of the over-center spring, which causes the same to take place under influence of the magnet. The circuits thus opened and closed by these contacts depend, of course, upon the outside connections.

From the foregoing description, it will be observed that the armature 20 and contact springs 26 are carried in an extremely simple manner upon an insulation base and that the over-center spring 21 is inserted in a way permitting these parts to be assembled and mounted as a unit, the feet of this spring being related to the feet of the iron frame 16 so that the air gap of the relay may be easily adjusted or secured initially in the assembly of the device. The relation of these parts and those of the coil and frame provides a very efficient device, both from construction and operational standpoints.

The sealing of the cover to the base of the relay, as set forth, may be accomplished in any desired way but depends somewhat on the materials of which the base and cover are composed. If, for example, both are the same plastic material, a solvent for that material may be applied to the joint between the two and the two will unite as one, the joint then forming a hermetical seal. If cover 10*a* is made of glass, the sealing of base 10 to form a hermetical seal may likewise be easily accomplished. Various combinations of materials may be used and the proper weld or joint between these two parts may be provided. By hermetically sealing in the relay, and particularly the contacts and operative parts thereof, their functioning under predetermined ideal operating conditions according to the design and intention of the maker is assured. If then the relay is called upon to do its work, say, at 40,000 feet altitude, where ordinarily the rarefied air and other conditions are apt to cause relay failure, this sealed relay does its work the same as ever.

The sealed-in operating conditions may be anything desired, including from a predetermined vacuum to a predetermined pressure, and the use of inert gases to prevent arcing and of dry air or gas to prevent the corrosive action often caused by moisture and other elements in the air as well as to prevent the wear of abrasive dust and eliminate the danger of combustible gases. Sealing in of the ideal conditions permits, of course, the sealing out of the objectionable ones. The gases may be injected into the casing and sealed therein by methods well known in the art. These methods may include, among others, blowing the gas through an opening in the housing 10*a* and then sealing as at 40, or by blowing the gas into the housing 10*a* at 10*b* during the sealing operation. This latter method may be used to flush the interior of housing 10*a* of air or other matter by flowing the gas into the housing at any point in the sealing edge 10*b* and to exhaust from another point therein, the operation continuing until the seal is formed.

Providing a relay in the form disclosed herein advantageously affords the use of a relay in the form of a unit assembly that may be readily inserted or replaced in a circuit without disconnecting the wires and resoldering the same to the contact springs. If plug contacts, such as those designated 34 herein, are used, the unit may be quickly inserted or replaced by employing suitable sockets in the circuit which provide for the reception of these plug contacts. On the other hand, if housing 10*a* is transparent, inspection of the connections at the contact springs of the relay to determine the condition of the connections and to assist in locating trouble as it occurs in the circuit, may be easily had through housing 10*a* without requiring the seal to be broken and the housing to be removed. The relay and the wiring connections at its contact springs may be made a permanent structure and the tedious task of securing the connections on the job may be eliminated. Protecting the relay and these contact springs and their wiring connections from dust and dirt when enclosed by housing 10*a* is a further advance in the use of relays from a practical standpoint because the life of the relay and of the parts is materially increased and wear and damage from accidental contact therewith are prevented. It will be understood that different forms of contact springs may be provided. The relay coil, together with the particular form of contact springs that is used, may be uniquely arranged in the aforesaid sealed relation in the housing 10*a* and used as a unit assembly. The unit assembly may be plugged in and out of the circuit without the use of tools or skilled labor to make the proper circuit connections. The relay and these connections will be kept free from dust, dirt and moisture at all times and may be used at different altitudes without its operation being impaired.

Having thus described the invention and one practical manner of carrying it out with effect, and appreciating that various changes, alterations and modifications may be made therein without departing from the spirit and scope of the invention as set forth in the appended claims,

what is claimed and desired to be secured by Letters Patent is:

1. A relay having a hermetically sealed housing and base through which circuit connections extend in hermetically sealed relation to maintain predetermined sealed-in operating conditions within said housing and base, and a nested magnet and contact structure supported upon said base within said housing including a coil, an inverted frame supporting said coil, an armature for completing the magnetic circuit between said coil and said frame, a series of contacts, and a spring member having means for carrying said contacts and said armature thereon, said spring member being confined between said coil and said base and being attached to said base by said inverted frame member to move in a direction toward and away from said base, and a second series of contacts on said base engageable by said first series of contacts carried by said spring member.

2. A relay having a hermetically sealed housing and base through which circuit connections extend in hermetically sealed relation to maintain predetermined sealed-in operating conditions within said housing and base, and a nested magnet and contact structure supported upon said base within said housing including a coil, an inverted frame mounting said coil upon said base, an armature for completing the magnetic circuit between said coil and said frame, a series of contacts, and a non-vibratory spring member movable in a direction toward and away from said base and said coil and having means for carrying said contacts and said armature in nested relation between said coil and said base, there being feet upon said inverted frame to secure said spring member in an over-center non-vibratory relation upon said base and beneath said coil.

3. A relay having a hermetically sealed housing and base through which circuit connections extend in hermetically sealed relation to maintain predetermined sealed-in operating conditions within said housing and said base, and a nested magnet and contact structure supported upon said base within said housing including a coil, a frame mounting said coil upon said base, an armature, a series of contacts and a U-spring having upstanding legs, the feet of said spring legs being attached to said base by said frame, said legs spacing the center portion of said spring above said base, there being means for attaching said armature and said contacts to said center portion to provide limited but non-vibratory movement to said parts.

4. A relay comprising an insulating base, a magnet, an inverted U-shaped bracket frame for the magnet, the ends of the legs thereof being offset and having feet secured to the base, said bracket supporting the magnet with its open end spaced from the base, an over-center spring spanning said space and secured to the base, an armature for the magnet carried by the spring, an insulating bar also carried by said spring, switch contact springs carried by said bar, said armature, spring, bar and contact springs being stacked in nested relation in said space, and fixed forward and back switch contacts in groups on the base in line with the ends of said contact springs and suitably bridged thereby in accordance to the position of said armature upon energization and deenergization.

5. A relay comprising an insulating base, an electromagnet secured over the base, an inverted U-frame over the electromagnet forming a supporting bracket therefor and a portion of its magnetic circuit, the legs of the bracket having offset portions forming poles for the electromagnet and other offset portions forming feet for securing the bracket to the base with the electromagnet spaced above the base, an over-center spring secured to the base in nested relation in the space between the electromagnet and the base, an armature for the electromagnet carried by said spring in operative relation thereto, an insulating plate carried by said spring, contact springs carried by said plate, and stationary switch contacts on the base to cooperate with said spring contacts in the operation of the electromagnet.

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