June 28, 1938. C. H. LARSON 2,121,804

OXIDIZED PLUNGER AND SPRING

Filed Oct. 17, 1934

Fig. 1

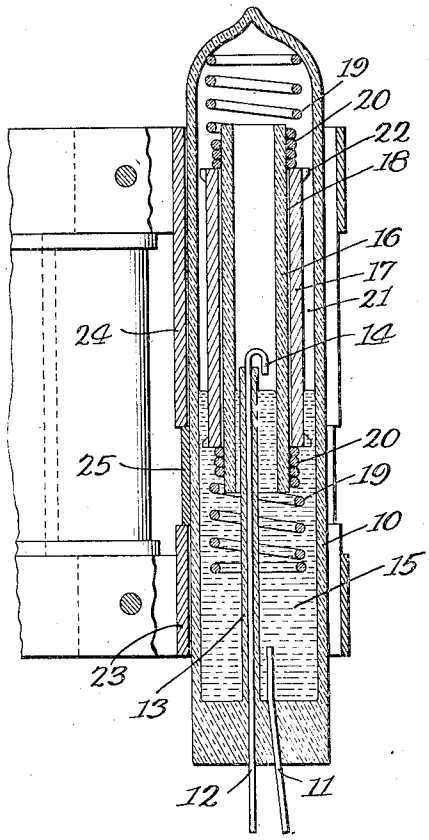
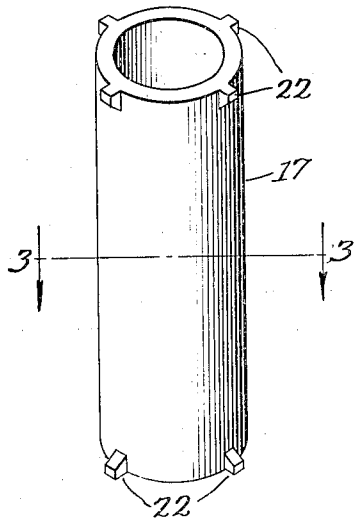


Fig. 2



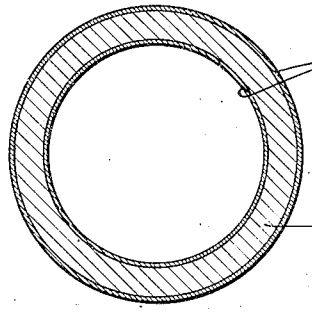


Fig. 3

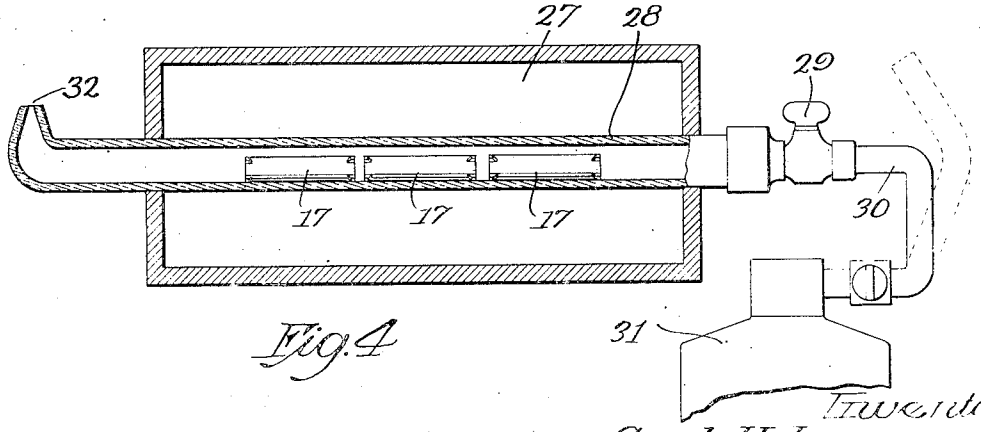


Fig. 4

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Patented June 28, 1938

2,121,804

UNITED STATES PATENT OFFICE

2,121,804

OXIDIZED PLUNGER AND SPRING

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Application October 17, 1934, Serial No. 748,585

6 Claims. (Cl. 200—112)

This invention relates primarily to mercury tube switches of the type including an armature of iron (which term shall include other ferro magnetic substances when appropriate) cooperating with the mercury, and cushion springs protecting the glass envelope from the iron.

Extended observation on switches of this type have revealed the facts that—

(1) In service the mercury sometimes loses its liveliness of movement and instead of holding away, or easily separating from the iron, as it should, it actually clings to the iron, with the result that the pick-up and drop-away values of the switches are changed and their desirable characteristics are reduced;

(2) A scum or powder of grayish color appears on the surface of the mercury, and seems to reduce its surface tension;

(3) These things occur more quickly, and advance more rapidly on directly current load, particularly the inductive type than they do on alternating current load;

(4) Such switches stored for months, and even years, are free from those effects, but upon being put into service develop them like new switches.

A simple and effective remedy, or rather preventive, is to prepare the armatures and springs, or any other iron articles by heating them just high enough and long enough in an oxidizing atmosphere to produce a black or bluish looking coat of what I assume is magnetic oxide, or ferrous ferric oxide of iron, entirely enclosing the armature or the body.

Lyman C. Newell, in his College Chemistry, 1925, at page 532, says—

"Iron forms an oxide (Fe_3O_4) if heated to a high temperature in steam or burned in oxygen. A thin film of this oxide adheres firmly and prevents rusting; iron so coated is called Russia iron."

Storer and Lindsay, in their Manual of Chemistry, copyright 1894, at page 372, say—

"The magnetic oxide of iron (Fe_3O_4) occurs native. It is the richest of the ores of iron, and, when pure, contains about 72 per cent of iron. This oxide may be regarded as a compound of FeO and Fe_2O_3, and it is sometimes called ferrous ferric oxide. In certain processes for producing rustless iron, articles are coated with this oxide by heating them in superheated steam, or in a mixture of combustible gases and air. The film of oxide thus formed protects the metal from further oxidation; for, unlike ferric oxide, the magnetic oxide does not carry in oxygen from the air to corrode the metal."

The processes referred to are numerous and varied. They are described in Ure's Dictionary, Vol. IV, Supp. 1879, at page 773; Kent's Mechanical Engineers' Pocketbook, 1901, at page 388; Kent's Mechanical Engineers' Handbook, 1923, at pages 478, 479.

While all these processes may be used, and the electrolytic Bower-Barff and Russia processes are particularly good, strict adherence to them as described in the references, does not appear to be indispensable. Merely heating piano wire springs over a Bunsen burner to about 650° F., and allowing them to cool in air, has been found sufficient in some instances.

After the armatures have been machine and polished they are annealed at around 1600° F. in hydrogen, or some other suitable atmosphere (Kent, 1901, cited at page 389). When they have cooled to about 650° F. (as may be shown by a pyrometer connected to the tube or casing in which they are heated) air or oxygen may be admitted in suitable quantity to produce the necessary coating.

Quartz tubes, surrounded by suitable furnaces, have been used for the annealing operation and suitable coating has been secured by admitting a small quantity of air or oxygen while the articles were at substantially 1600° F., but care was taken to not admit sufficient oxygen to produce a loose scale. Apparently there were occluded gases in the quartz that assisted in this operation, or perhaps they permeated the quartz from the outside.

The coating should entirely envelop the armature, or spring, or other article; and, in the case of the armature, it should be polished to the end that the surface presented to the mercury may be smooth and even. As the springs are not required to enter or leave the mercury in any particular manner during the operation of the switches, the polishing after coating is not necessary.

Assuming, as has been done, that the result of the various treatments is a coating or envelope of magnetic oxide, the temperature and the time of exposure are variable for the same material and must be varied for different materials. The maker of the iron, steel, or other alloy can supply the approximate temperature, and a little testing will reveal the best temperature to use.

Armatures that have been treated according to this invention show an electric resistance of approximately one hundred times that of annealed non-treated specimens otherwise the same.

From the facts that the change in the mercury,

or in the iron, or both, does not occur in switches not used, but does occur after current is applied, and then is more pronounced with direct current (the current used for electroplating) than with alternating current, and the further fact that it is checked, or prevented by high resistance, it seems fair to assume that the flow of direct current through the springs and displacers, or armatures, is the cause, or a principal cause of the damaging effect.

If so, the gist of the solution would appear to lie in increasing the resistance through the iron as compared with the resistance through the mercury. The heat treatment described apparently, and probably does enclose the iron in an insulating, or poor conducting envelope of black oxide of iron.

Fig. 1 is a vertical section through one form of mercury tube switch and parts of an electromagnet associated therewith;

Fig. 2 is a perspective view of the soft iron armature located within the glass envelope;

Fig. 3 is an enlarged transverse section on the line 3—3 of Fig. 2;

Fig. 4 is a diagrammatic representation of the heat treating apparatus.

An envelope 10 of suitable glass such as borosilicate, disclosed in Weintraub, No. 1,154,081, has sealed in it lead-in wires 11 and 12 of tungsten, molybdenum, tantalum, or the like, the lead-in wire 12 being shielded by a glass tube 13 to a considerable height and then bent over at 14 to form an electrode for contact with the surface of purified mercury 15 when the switch is operated.

The mercury is displaced by a composite displacer, including a sleeve 16 of quartz, glass, or other ceramic material, telescoped within a cylindrical armature 17 of ferro magnetic material, in this instance Swedish iron, known as Svea iron. The sleeves fit together with ample clearance 18 to allow for the differences in expansion, and are held in assembled relation by springs 19 made of piano wire, or any steel or metal that will not react with the mercury. The springs are coiled generally in the form of a helix with one end portion 20 reduced in diameter to frictionally bind on the sleeve 16 at the opposite ends of the armature 17.

The atmosphere within the envelope 10 is helium, hydrogen, a mixture of those two, or any other suitable gas.

The armature is considerably smaller in diameter than the envelope 10 to provide ample clearance 21, and the armature is equipped with narrow guides or fingers 22 to preserve this relationship without materially obstructing the flow of the gas fill or the mercury through the clearance space 21, as the displacer changes its position.

The mercury tube switch, as a whole, is held between pole sleeves 23 and 24 of an electromagnet by a split sleeve of brass 25, which frictionally clasps it in the area between the pole sleeves and allows it to be easily adjusted to its appropriate position within the magnetic field.

In Fig. 3 the coating of magnetic oxide is illustrated at 26 though, of course, the relative proportion to the thickness of the armature is only roughly true.

In Fig. 4, 27 indicates the barrel of a gas or electric oven through which is inserted a quartz tube or cylinder 28 fitted with a cock 29 and connected by hose 30 with a hydrogen tank 31. Within the cylinder 28 are armature sleeves 17.

When the furnace is being used for annealing it is brought up to the proper temperature and the cock 29 being open, hydrogen flows through the quartz tube and is ignited at the left end 32, as it escapes to the atmosphere. When the annealing period is over the cock 29 is closed, the hose 30 is disconnected from the hydrogen tank and connected with a source of helium, nitrogen, or other inert gas, and the cock reopened until all of the hydrogen has been driven out of the tube 28, then the cock 29 is closed, the hose 30 disconnected from the source of helium, and the like, and connected to a source of oxygen (which may be the atmosphere) and the cock 29 is opened to admit oxygen to the tube 28.

If the parts under treatment are still at a high temperature the quantity of oxygen will have to be kept very low, otherwise they will burn and are likely to form a loose scale.

I claim:

1. A mercury tube switch comprising a switch envelope, mercury therein, spaced electrodes in the envelope, a ferrous body in the mercury, means for manipulating the mercury to bridge the electrodes thereby to complete an electrical circuit through the electrodes, and means for preventing deterioration of the mercury by the ferrous body in the mercury, said means including an oxide coating on the ferrous body.

2. An armature for mercury tube switches composed of ferro magnetic material entirely enclosed within an envelope of black oxide of iron.

3. An armature for mercury tube switches composed of ferro magnetic material entirely enclosed within an envelope having greater electric resistance than mercury.

4. An armature for mercury tube switches composed of ferro magnetic material entirely enclosed within an envelope of insulating material.

5. An armature for mercury tube switches composed of ferro magnetic material entirely enclosed within an envelope of its oxide.

6. A spring of piano wire for use in a mercury tube switch entirely enclosed within an envelope of its oxide.

CARL H. LARSON.