April 21, 1953 I. S. JACOBSEN 2,636,077

STARTER FOR FLUORESCENT LAMPS

Filed March 3, 1950

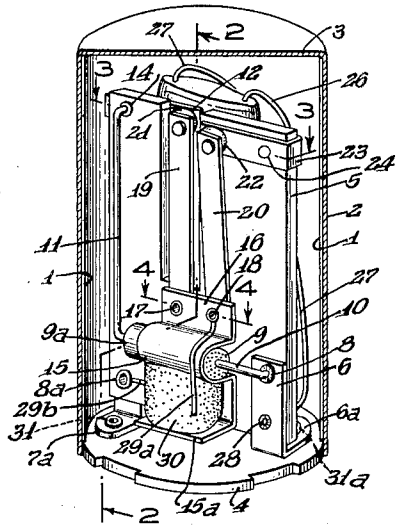


FIG. 1.

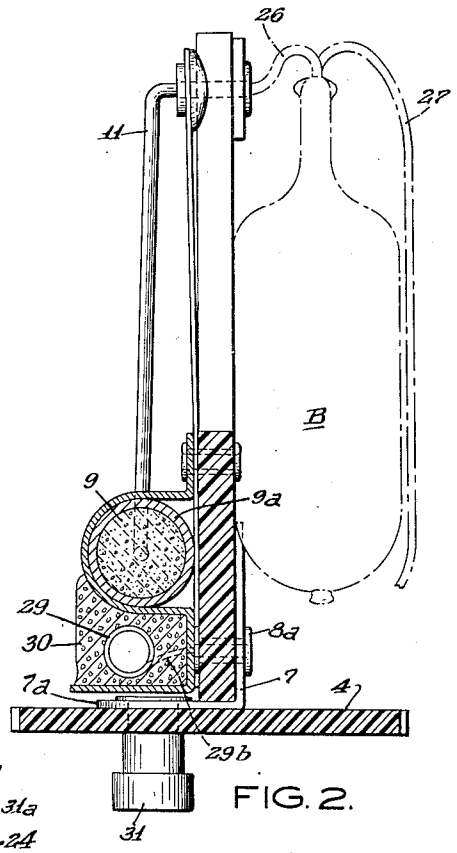


FIG. 2.

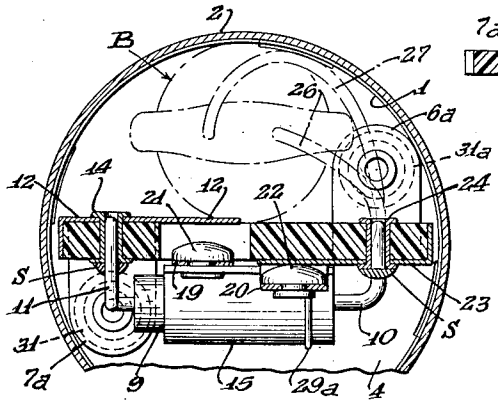


FIG. 3.

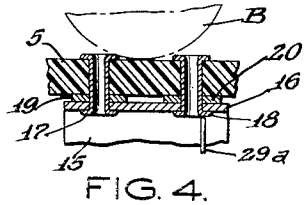


FIG. 4.

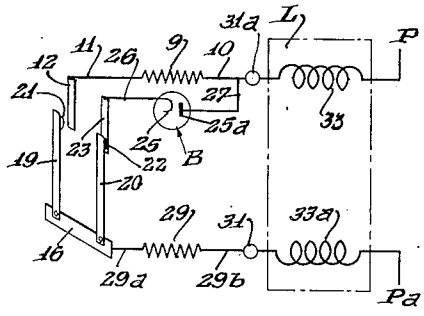


FIG. 5.

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Patented Apr. 21, 1953 2,636,077

UNITED STATES PATENT OFFICE

2,636,077

STARTER FOR FLUORESCENT LAMPS

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Application March 3, 1950, Serial No. 147,499

8 Claims. (Cl. 175—320)

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My invention relates to a new and improved starter for fluorescent lamps, of the type and operation described in Babb United States Patent No. 2,341,520, issued on February 15, 1944.

This Babb patent discloses a single bimetal switch blade, which is located between a main fixed contact, and an auxiliary fixed by-pass contact. At normal temperature, the bimetal switch blade touches said main fixed contact and it is spaced from said by-pass contact. The main fixed contact is part of a main circuit which includes a glow-switch. The main circuit of said bimetal switch blade includes a heater coil. If the fluorescent lamp is in good condition, it is started after a selected period, thus by-passing the starter. If the fluorescent lamp is defective, said heater coil heats the bimetal switch blade sufficiently to deflect said bimetal switch blade away from said main fixed contact to touch the auxiliary fixed by-pass contact, thus closing a high-resistance by-pass holding circuit, thus producing enough heat to maintain the switch blade in its deflected position, until the defective fluorescent lamp is removed from its socket to open the high-resistance by-pass circuit, so that the single bimetal switch blade cools to again touch the main fixed contact.

In such a device, the single bimetal switch blade must be under initial flexure, in order to keep it reliably in contact with the main fixed contact at normal temperature. The normal temperature of the working location of a starter may vary 80° F. and even more. The initial preset pressure of the contact head of the single bimetal switch blade against the main fixed contact must be sufficient to resist a change in ambient temperature of 80° F. or more.

The high-resistance carbon resistor of the by-pass circuit must start from zero heat, and develop enough heat quickly to offset the bias of the single bimetal blade towards the main fixed contact, which is produced by this initial flexure. These factors require critical control of initial flexure, accurate spacing between the main fixed contact and the auxiliary by-pass fixed contact, and accurate heat transfer relation. These factors require great accuracy in production.

Such starters must be made of small size, to fit into the standard starter can, which has a diameter of 0.750 inch and a height of 1.250 inches.

According to my invention, I provide a device which requires much less labor cost, and which can be made accurately and reliably on a large scale, while using the same principle as said Babb patent.

Other objects and advantages and features of my invention are stated in the annexed description and drawings.

Fig. 1 is a perspective view, with a part of the representation of the inner sleeve and the metal can omitted;

Figs. 2, 3 and 4 are respectively sections on the lines 2—2, 3—3 and 4—4 of Fig. 1; and

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Fig. 5 is a circuit diagram showing the starter assembled with a fluorescent lamp.

The device is enclosed in the usual sleeve 1, which is made of suitable insulating material. Said sleeve is held in the usual metal can 2, which has a top-wall 3.

The base 4 of the device is made of insulating material. For convenience, said base 4 is shown in the horizontal position of Fig. 1. A vertical panel 5, made of insulating material, has a vertical recess at its upper edge, to provide two vertical legs.

Panel 5 is fixed to base 4 by angular metal brackets 6 and 7, which have respective horizontal legs 6a and 7a. The vertical arms of metal brackets 6 and 7 are fixed to panel 5 by respective metal eyelets 8 and 8a.

The horizontal legs 7a and 6a of brackets 7 and 6 are associated with respective metal contact posts or prongs 31 and 31a which are located at opposite sides of panel 5. These posts or prongs 31 and 31a are identical. Each said post or prong 31 or 31a is hollow and it has a reduced upper end which extends through base 4 and the respective horizontal leg 7a or 6a. The upper end of each post or prong 31 and 31a is enlarged to form an angular head, as by spinning or other method, to provide a rivet-like connection whereby each post or prong 31 and 31a and its respective associated leg 7a and 6a are fixed firmly to base 4. Each post or prong 31 and 31a has a shoulder which abuts the bottom face of insulating base 4.

The device comprises a main resistor heater 29 and a by-pass resistor heater 9. The main resistor heater 29 may be a coil of wire, and the by-pass resistor 9 may be a carbon resistor, of much greater resistance than the main resistor 29. By-pass heater coil 9 is located in an insulating casing 9a and main heater 29 is located in an insulating casing 30.

A metal and heat-conductive clamp support 15 has a convex main body, a top vertical flange 16 and a bottom horizontal flange 15a.

Top vertical flange 16 is fixed to panel 5 by means of metal eyelets 17 and 18, which are also fixed and conductively connected to the lower base ends of respective bimetal switch blades 19 and 20. These eyelets 17 and 18 electrically connect metal clamp support 15 to said base ends of blades 19 and 20. Also said switch blades 19 and 20 are in good heat-conductive relation to heat-conductive support 15.

The insulating casing 9a of the by-pass resistor 9 is held clamped against panel 5 by the convex main body of support 15.

The insulating casing 30 of main resistor 29 is fixed to support 15 in the space between the convex main body and flange 15a.

The respective ends of by-pass resistor 9 are connected to respective terminal wires 11 and 10.

Wire 10 is connected to metal eyelet 8, which fixes metal bracket 6 to insulating panel 5, thus providing electrical connection between one end

of by-pass resistor 9, metal bracket 6, and metal post or prong 31*a*.

Wire 11 extends to the respective upper vertical leg of panel 5, and it is connected to a metal eyelet 14 which fixes a first horizontal angular metal contact 12 to the respective leg of panel 5. Solder S may be provided as desired, in order to improve electrical connection at said eyelet 14 or any other eyelet or connection point. The post or prong 31*a* is thus electrically connected through by-pass resistor 9 and intermediate connections to said first contact 12, which is designated as the by-pass contact.

One end of main resistor coil 29 is connected by wire 29*b* to metal eyelet 8*a*, which fixes metal bracket 7 to insulating panel 5. The other end of main resistor coil 29 is connected by wire 29*a* to metal flange 16 and hence to the base ends of both bimetal blades 19 and 20. The post or prong 31 is thus connected through main resistor 29, and intermediate connections, to the base ends of both blades 19 and 20.

A second horizontal, angular metal contact 23 is fixed to the respective vertical leg of panel 5 by a metal eyelet 24. The horizontal legs of the first and second metal contacts 12 and 23 are at opposite sides of the respective vertical legs of panel 5.

The upper ends of blades 19 and 20 have respective contact heads 21 and 22.

Blade 19 is located in the space between the vertical top legs of panel 5. At normal temperature, the contact head 21 of blade 19 is spaced transversely from first contact 12 and the contact head 22 of blade 20 normally touches the second contact 23.

A wire 27 has one end connected by means of eyelet 26 to bracket 6, and hence to post 31*a* and one end of by-pass resistor 9. The other end of this wire 27 is connected to a bulb terminal of the usual glow-switch B, said bulb terminal being connected to the bimetal glow-switch electrode 25*a* of said glow-switch bulb B.

The other glow-switch electrode 25 of glow-switch bulb B is connected to a bulb-terminal which is connected by wire 26 to metal eyelet 24 which is fixed to contact 23 secured to panel 5. Bulb B is fixed to panel 5 by the wires 26 and 27, which have sufficient rigidity for this purpose.

Fig. 5 shows a fluorescent lamp L, which has respective lamp-electrodes 33 and 33*a*, which emit electrons when heated to a suitable high electron-emissive temperature.

The upper ends of lamp-electrodes 33 and 33*a* are connected to respective power mains P and P*a* of a source of electric current, which is usually alternating current. The power circuit P—P*a* includes the usual inductor coil or ballast coil, not shown in the drawings.

The lower ends of lamp-electrodes 33 and 33*a* are connected to the usual terminals of the usual starter socket, not shown. When the posts or prongs 31 and 31*a* are inserted into said starter socket, said posts or prongs 31 and 31*a* are connected respectively to the lower ends of lamp-electrodes 33 and 33*a*, in the usual manner.

When the power circuit is closed, the blade 20 then touches contact 23 and blade 19 is then spaced from contact 12. This produces an initial closed circuit, as from power main P*a* through lamp-electrode 33*a*, to post 31, through main heater 29, through main bimetal blade 20 to main contact 23, through glow switch bulb B, by an ionization discharge between its glow-switch electrodes 25 and 25*a*, to post 31*a*, and through lamp-electrode 33 to power main P. At this stage, no current flows through by-pass blade 19 or by-pass resistor 9.

An ionization or glow discharge is produced in the gaseous filling of glow-switch bulb B, in the usual manner, so that at the end of a selected period, the bimetal glow-switch electrode 25 is flexed from its normal shape of Fig. 5 to touch glow-switch electrode 25*a* in the usual manner, thus extinguishing the glow discharge, and establishing a closed metal circuit through the lamp-electrodes 33 and 33*a*.

The interruption of the glow discharge through glow-switch bulb B cools the bimetal glow-switch electrode 25, thus causing it to deflect away from the other glow-switch electrode 25*a* at the end of a selected period, thus opening said closed metal circuit after the lamp-electrodes 33 and 33*a* have been heated to electron-emissive temperature, whereupon the inductive effect of the inductor coil or ballast coil in the power circuit produces a discharge in lamp L across the space between its lamp-electrodes 33 and 33*a*.

The main low-resistance heater 29 heats both blades 20 and 19 by conduction through the heat-conductive support 15. Such heat tends to flex blade 20 away from its contact 23, thus tending to open the main starter circuit at contact 23. Such heat of the low-resistance heater 29 tends to flex by-pass blade 19 towards by-pass contact 12, thus tending to close the by-pass circuit. If the lamp L is a good lamp, and its discharge across the space between its electrodes 33 and 33*a* is started at the end of a selected period, and such lamp discharge is maintained, the entire starter will be by-passed, the glow-switch electrodes 25 and 25*a* will remain separated after their initial contact and separation, and the starter will consume no current, because no glow discharge is produced in glow-switch bulb B.

If the lamp L is defective when the power circuit is closed or after the lamp L has been operating on a closed power circuit, said lamp L will flash on and off, thus prolonging the period in which heating current is supplied to main resistor 29. While said lamp L flashes on and off, a series of intermittent glow discharges will be produced in glow-switch bulb B. Each glow discharge in bulb B will be extinguished when lamp L flashes on, and there will be a new glow discharge in bulb B when lamp L flashes off.

The main bimetal blade 20 will thus be sufficiently heated by the heat which is supplied by main heater resistor 29 by conduction through support 15, to open the main circuit by separating contact head 22 of blade 20 from its contact 23. Simultaneously, the heat which is supplied by main low-resistance resistor 29 will flex bimetal blade 19 towards contact 12, in order to close the by-pass holding circuit which includes the high-resistance by-pass carbon resistor 9. The by-pass holding circuit is thus closed before the contacts 22 and 23 are separated from each other. Hence, neither the amount of deflection of the bimetal electrode 20, nor the speed of deflection of said bimetal electrode 20, has any effect on the operation, because the by-pass circuit is closed before metal to metal contact is interrupted in the circuit of bulb B and blade 20. This is an important feature of the invention.

The flat and planar bimetal blades 20 and 19 are deflected in opposite directions by the heat which is generated by main heater 29.

When the by-pass holding circuit is closed, the metal support 15 and the main heater re-

sistor 29 have enough heat to keep the by-pass blade 19 in circuit-closing position, while the carbon high-resistance by-pass resistor 9 develops enough heat to keep the blade 20 in circuit-opening deflected position and to keep the blade 19 in deflected circuit-closing position.

Time studies have shown a reduction in number of operator minutes per piece to 40% of that previously required.

A series of tests have been made with a device in which the blades 19 and 20 had respective lengths of 1.0 inch.

The preset pressure of the contact head 22 against its contact 23, due to initial pre-set flexure of blade 20, varies from 7.0 grams to 8.0 grams, with an average pre-set pressure of 7.5 grams.

A series of cycling tests have been made. Each cycling test consisted of a complete series of operations, namely, attempting to start a defective fluorescent lamp, and removing the fluorescent lamp to permit the two bimetal blades to cool and to flex back to their normal positions of Fig. 5. Each starter was thus cycled 100 times in continuous succession. There was some slight destruction of the silver contact 22 by arcing, but the change in operating time was very slight. During these 100 cycling tests, the ambient temperature was in a range of 167° F. to 181° F.

Other satisfactory cycling tests have been made while each starter was immersed in melting ice.

During both types of tests, the starters operated satisfactorily, without a tendency to re-cycle.

Other tests have shown that the starter operates to cut out the fluorescent lamp during a blinking period of 20 seconds to 40 seconds, and at a designed ambient temperature of 32° F. to 150° F.

The lighting period of the fluorescent lamp is 10 seconds at a power line voltage of 120 volts, and 15 seconds at a power line voltage of 105 volts.

When the by-pass holding circuit is closed by a blinking lamp, its power consumption is from 1.1 to 1.3 watts. This power consumption is sufficient to keep the blades 19 and 20 deflected from their normal positions of Fig. 5, thus preventing objectionable re-cycling.

Since the by-pass holding circuit is normally open, there is no power consumption in the starter if the fluorescent lamp is a good lamp.

The preset pressure is secured by selecting the thickness of the silver contact head 22 and the thickness of contact 23.

Although each blade 19 and 20 is connected to flange 16 by a single eyelet, a substantial part of the bottom end-part of each said blade is clamped to panel 5, thus preventing the blades 19 and 20 from pivoting around their respective eyelets 17 and 18. The drawings are substantially to scale and provide further disclosure.

The active length of each contact blade 19 and 20 is substantially 0.7 inch.

The spacing of contact head 21 of blade 19 from its contact 12 is provided by the thickness of panel 5. Its thickness is 0.063 inch, with a variation of plus or minus 0.003 inch.

Each bimetal blade has a thickness of 0.005 inch and it is made of material similar to that of the thermostatic metal known to the industry as "Rayflex."

If the active length of each blade 19 and 20 is approximately 0.7 inch, namely, $\frac{3}{4}$ of an inch, the fixed panel contact 23 preferably has a thickness of 0.014 inch for an operating ambient of 150° F., and the thickness of the silver metal contact 21 or 22 of each blade 19 or 20, is preferably 0.036 inch from its shoulder to its top.

It is desirable to select the material of the metal support 15. Thus, if said metal support 15 is made of copper, it has high heat conductivity, but it cools rapidly, thus resulting in objectionable recycling. By using a metal support 15 which is made of copper-plated steel, and making the main heater coil 29 of suitable ohmic resistance, as 12 ohms, efficient heat conduction was secured without recycling.

The resistor 29 is preferably embedded or located in ceramic material or other material which supplies the heat which is required to maintain the blades 19 and 20 in their deflected positions, until the high-resistance heater 9 can supply the necessary holding heat.

For convenience, the face of panel 5 at which both blades 19 and 20 and contact 23 are located, is designated as the front face of panel 5, and the face of panel 5 at which contact 12 is located is designated as the rear face of panel 5.

I have described a preferred embodiment of my invention, but numerous changes and omissions and additions and substitutions can be made without departing from its scope.

I claim:

1. A starter which comprises a base made of insulating material and a panel made of insulating material, said panel extending upwardly from said base, said panel having a front face and a rear face which are in transverse relation, a first angular metal bracket, which has a first panel-arm and a first base-arm, said first base-arm being fixed to said base and to a first metal pin which depends from said base, said first panel-arm being located at and being fixed to the front face of said panel, said first base-arm extending rearwardly from said panel, a second angular metal bracket which has a second panel-arm and a second base-arm, said second base-arm being fixed to said base and to a second metal pin which depends from said base, said second panel-arm being located at and being fixed to the rear face of said panel, said second base-arm extending forwardly from said panel, a main contact fixed to said front face, a by-pass contact fixed to said rear face, a main bimetal switch blade, a by-pass bimetal switch blade, said bimetal switch blades having their base-ends located between a metal support and the front face of said panel, said metal support being fixed to said panel and holding said base-ends of said blades to the front face of said panel, said main switch blade being biased normally to touch said main contact, said panel having an opening which is laterally intermediate said contacts, said by-pass blade being normally spaced from said by-pass contact and being bendable through said opening under the action of heat to touch said by-pass contact, said main blade being bendable under the action of heat to separate from said main contact, a main low-resistance heater resistor, a by-pass high-resistance heater resistor, said resistors being held in fixed relation to said panel at its front face by said metal support and being insulated from said metal suport, one end of said main resistor being electrically connected to said metal support and to the base-ends of said blades, the other end of said main resistor being connected to said second panel-arm, one end of said by-

pass resistor being connected to said by-pass-contact, the other end of said by-pass resistor being connected to said first panel-arm, a glow-discharge bulb located at said rear face, said glow-discharge bulb having normally separated electrodes, at least one of said electrodes being bimetallic to produce contact between said electrodes under the action of heat, one of said electrodes being connected to said first panel-arm, the other electrode being connected to said main contact, both said resistors being in heat-conductive relation to said metal support and heating said blades upon the passage of current through them.

2. A starter for a fluorescent lamp, said starter having a main bimetal switch blade and a by-pass bimetal switch blade, said main bimetal switch blade being associated with a main contact and normally contacting said main contact, said by-pass bimetal switch blade being associated with a by-pass contact and being normally spaced from said by-pass contact, a main low-resistance heater resistor and a by-pass high-resistance resistor, one end of said main resistor being connected to both said blades, the other end of said main resistor being adapted to be connected to a lamp-electrode of a fluorescent lamp, one end of said by-pass resistor being connected to said by-pass contact, the other end of said by-pass resistor being adapted to be connected to the other lamp-electrode of such fluorescent lamp, a switch having normally separated switch-terminals, one switch-terminal being connected to said main contact, the other switch-terminal being connected to said other end of said by-pass resistor, both said resistors being located in heat-producing relation to said blades, said main resistor generating enough heat upon prolonged passage of current to flex said by-pass blade to contact said by-pass blade with said by-pass contact and to flex said main blade, separate said main blade from said main contact, said by-pass resistor generating enough heat upon the closing of its by-pass circuit to maintain said by-pass blade in contact with its by-pass contact and to maintain said main blade separated from its main contact, said switch having means to connect its terminals by metal to metal contact upon application of a suitably high switch-operating voltage to said switch-terminals and to disconnect said switch-terminals when said applied voltage drops below said switch operating voltage.

3. A starter according to claim 2, in which said blades are flexed in opposed directions.

4. A starter according to claim 2, in which said blades are thus flexed while said metal to metal contact is maintained.

5. In a starter for a fluorescent lamp, the sub-combination of an insulating panel which has transversely opposed front and rear faces, each said face having a respective metal contact thereat, two bimetal switch blades located at one of said faces, said switch blades having adjacent base-ends which are fixed to said panel, one of said switch blades normally contacting with the metal contact which is located at the same face as said blades, said panel having an opening which exposes the contact which is located at the face which is opposed to the face at which said blades are located, the other switch blade being normally spaced from said last-mentioned contact and being movable through said opening to touch said last-mentioned contact.

6. A sub-combination according to claim 5 in which said panel has a low-resistance electrical heater and a high-resistance electrical heater connected to said panel in heat-transmitting relation to said blades, one end of said low-resistance heater being connected to both said blades, the other end of said low-resistance electrical heater being connected to a respective terminal, one end of the high-resistance electrical heater being connected to another respective terminal, the other end of said high-resistance electrical heater being connected to said last-mentioned contact.

7. A starter for a discharge lamp which has spaced discharge-lamp electrodes, said starter including a main circuit and a by-pass circuit, both said circuits having one common terminal which is adapted to be connected to one end of one of said discharge-lamp electrodes, the other ends of said circuit being terminal ends which are adapted to be connected to one terminal of a source of electric power, said main circuit including a discharge-bulb which has an ionizable filling, said main circuit also including a main electric heater, said by-pass circuit including a by-pass electric heater, said by-pass circuit and its by-pass heater by-passing said main electric heater and said discharge-bulb, said main circuit including a main thermal switch which is biased by a respective biasing force to normal circuit-closing position, said by-pass circuit including a by-pass thermal switch which is biased by a respective biasing force to normal circuit-opening position, said discharge-bulb including normally spaced and conductive discharge-bulb electrodes, at least one of said discharge-bulb electrodes being thermally responsive to touch the other discharge-bulb electrode under the action of heat, which is produced by a discharge through said filling both said switches being in the heating zone of said main electrical heater, the heat generated by said main electrical heater urging said main switch to circuit-opening position and urging said by-pass switch to circuit-closing position, the heat generated by said main electrical heater being insufficient to change said normal positions of said switches during a single cycle of operation of said discharge-bulb in which its electrodes contact and then separate, said heat generated by said main electrical heater during a plurality of said cycles of operation which correspond to a defective lamp being sufficient to move said main switch to circuit-opening position and to move said by-pass switch to circuit-closing position, said by-pass switch being in the heating zone of said by-pass electrical heater, the heat generated by said by-pass electrical heater being sufficient to keep said by-pass switch in when the by-pass circuit is closed.

8. A starter according to claim 7 in which the biasing force applied to said by-pass switch is less than the biasing force applied to said main switch, so that said by-pass switch is closed before said main switch is opened.

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