

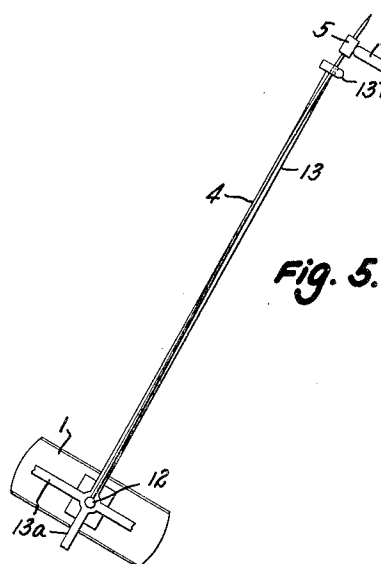
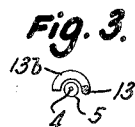
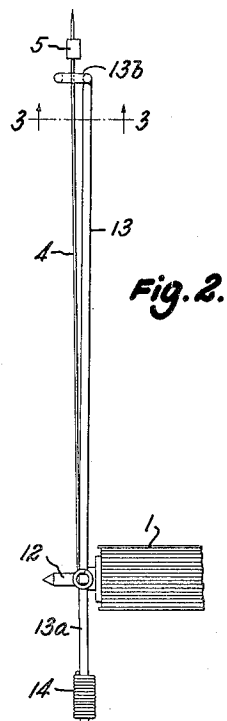
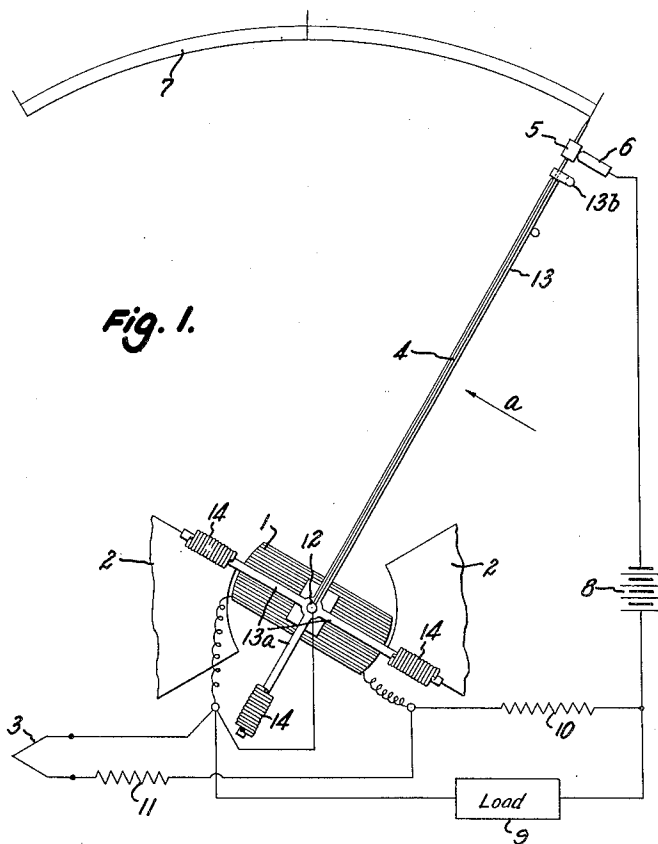
Jan. 17, 1950

A. H. LAMB
CONTACT ARM FOR SELF-RESETTING
MAGNETIC CONTACT RELAYS

2,494,622

Filed Feb. 6, 1948

2 Sheets-Sheet 1



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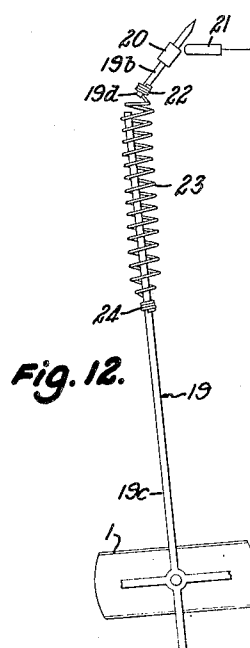
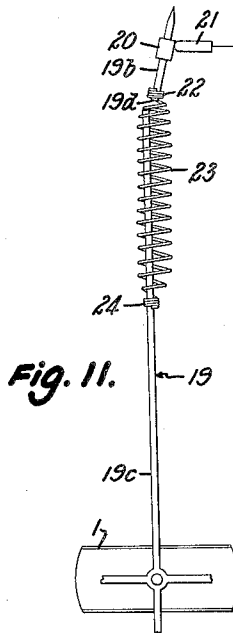
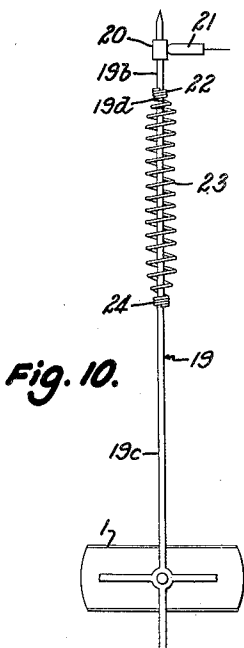
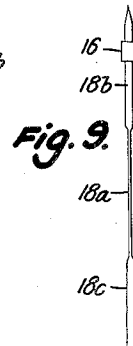
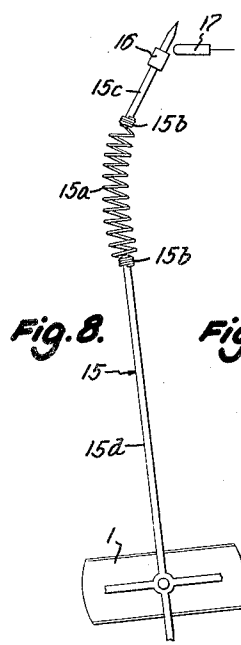
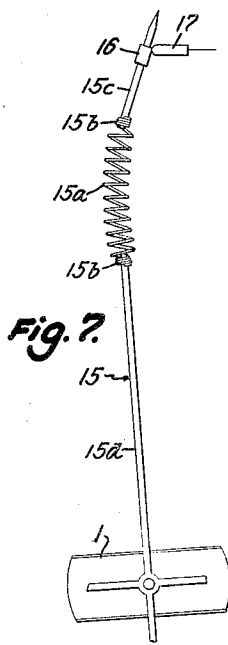
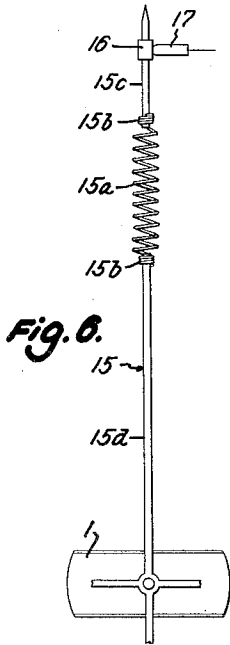
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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CONTACT ARM FOR SELF-RESETTING
MAGNETIC CONTACT RELAYS

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This invention relates in general to highly sensitive instrument relays of the magnetic contact type, and in particular to those in which the contacts are separated, i. e. reset, by the application of a counter torque to the moving system.

As shown in my prior United States Patent No. 2,346,589, issued April 11, 1944, such a counter torque may be obtained in a single coil instrument by passing a relatively high resetting current pulse through the moving coil in a direction opposite to that traversed by the control current; or by providing one coil for the control current and a separate one for the resetting current. In either case, the resetting current is maintained until the counter torque developed thereby is sufficient to overcome the forces of magnetic attraction between the contacts whereupon the contacts separate and likewise open the resetting current circuit.

To assure a reliable non-chattering engagement between the two contact members, the magnetic forces of attraction between them should be as high as possible but the upper limit of this force is determined by the maximum allowable magnitude of the resetting current and the period during which it may be safely applied to the delicate coil without overheating the latter. Thus in designing the instrument, a magnetic attractive force factor is chosen which will be sufficient to hold the contacts firmly together but which will nevertheless be certain to be overcome by the counter torque developed by the resetting current within a comparatively brief period.

In the case of a single coil instrument for example where both the control current and the temporary resetting current traverse the same winding, and the instrument is designed for a continuous control current input of the order of several microamperes, it has been the practice in the industry to use a resetting current of a substantially higher order of a few milliamperes in order to effect contact separation.

So long as the mutually engaging surfaces of the contact members remain smooth, satisfactory operation of the relay can be expected. However, experience has shown that even with currents in the milliamperage range, contact arcing cannot always be avoided and this quite often causes the surfaces of the contacts to pit.

Pitting of the contacts causes them to stick and thus adds an additional attractive force which must be overcome by the counter torque developed by the reset current. While this is taken into consideration in designing a particular

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instrument, so that the developed counter torque will be sufficient despite a limited amount of contact sticking to effect a separation of the contacts within the calculated period during which the reset current can be safely applied without fear of coil damage, it is quite possible especially when the contacts become deeply pitted, that the reset current period will be unduly prolonged with the result that the coil then becomes overheated to such extent that the insulation on the winding is damaged.

The general object of this invention is to provide an improved construction for the moving system of sensitive relay instruments of the class described which will always assure a positive and quick separation of the magnetically attracted contacts to the end that the reset current period will be certain never to exceed the maximum for which the instrument is designed.

In general, the objective is attained by a novel structural arrangement of the pointer element which permits the moving system to quickly gain an initial angular momentum in the contact separating direction, which momentum is then applied suddenly as a contact separating force as distinguished from the present conventional practice of increasing the contact separating force gradually from the instant that the reset current is applied which results in a slow and not always effective start of the moving system.

In one form of the invention, the moving system of the instrument includes a relatively flexible pointer which carries the movable contact near the outer end, and an auxiliary and relatively stiff arm which, after gaining an initial momentum with the moving system, functions to strike a sudden "hammer" blow against the flexible pointer close to the movable contact.

In another form of the invention, a single relatively stiff pointer element is used, but the pointer shaft includes a highly flexible section near its outer end adjacent the movable contact which permits the inner end of the pointer shaft and the remainder of the moving system to gain an initial momentum in the contact separating direction before the contact separating force is suddenly applied to the outer portion carrying the contact.

In yet another form of the invention, the structural features of both of the above mentioned embodiments are combined to bring about a separation of the contacts.

In the accompanying drawings, Fig. 1 is a view in front elevation illustrating the first referred to form of the invention as applied to an instru-

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ment relay of the single coil type, together with the circuit arrangement illustrated in Fig. 1 of my prior United States Patent No. 2,346,589; Fig. 2 is a side elevation as viewed from the right in Fig. 1; Fig. 3 is a horizontal section taken on line 3—3 of Fig. 2;

Fig. 4 is a similar sectional view illustrating a modified construction for the outer end of the reset arm; and Fig. 5 is a view similar to Fig. 1 illustrating the positions taken by the pointer and reset arm shortly after the reset current has been applied to the coil.

Figs. 6, 7 and 8 are front elevations of a modified form of the invention featuring a single pointer element including a flexible helical coil section adjacent the movable contact member, and which show, in sequence, the behavior of the pointer during the contact separating phase of the relay system;

Fig. 9 is a fragmentary elevation of another pointer arrangement similar to that shown in Figs. 6, 7, 8 but in which the flexible portion at the outer end of the pointer is constituted by a straight shaft section of reduced dimension.

Figs. 10, 11 and 12 are front elevations showing in sequence the mode of operation of yet another embodiment of the invention which, in general, combines the features of the pointer construction of Figs. 1-5 with that of Figs. 6-8.

Referring now to Figs. 1-5, the instrument relay is seen to be of the well known direct current type including a pivoted coil 1 rotatable in the air gap of a permanent magnet 2 and which is connected to a variable control current source 3 that develops only a small current flow through the coil 1, for example, of the order of a few micro amperes.

For purposes of illustration, current source 3 is shown diagrammatically as a thermocouple but it is to be understood that such source may be a photoelectric cell, a potentiometer, or the potential drop across a temperature-variant resistance, according to the character of the factor or quantity being measured.

A pointer 4 rotated by coil 1 carries at its outer end a small rider or contact 5 of magnetic material for cooperation with a relatively stationary magnetic contact 6. The magnetized contact 6 is so positioned that contact 5 is drawn into engagement with it when pointer 4 has rotated in a clockwise direction to a predetermined graduation on the scale 7 by the flow of the control current through coil 1. A load circuit including a current source 8 and a load device 9 is connected between the relay contacts 5, 6. The load device 9 may be a visual or an audible signal, a motor, or a power relay according to the desired control or relay action. Furthermore, in some cases, it may be desirable to use magnetized material for the movable contact member 5 and magnetic material for the stationary contact 6.

The resetting current may be drawn from the power source 8 of the load circuit by shunting the relay coil 1 across the load device 9, a resistor 10 being included in the coil branch of this parallel circuit network to limit the resetting current flow to a magnitude that will not damage the coil 1, assuming of course that the current is not applied for too long a period. In general, as previously explained, the resetting current may be of the order of a few milliamperes when the relay is designed for a continuous control current input of the order of several microamperes. The control current source 3 is

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in shunt with coil 1 so far as concerns current flow from the power source 8, and a current limiting resistor 11 is placed in series with source 3 to restrict the flow of power current through the source 3.

An engagement of the magnetic relay contacts 5, 6 closes the load circuit to energize the load device 9 from the battery 8, and also completes the resetting circuit through the resistor 10 and coil 1. The polarity and magnitude of the resetting current flow through the instrument coil 1 are such that the coil rotates counter-clockwise. When relay contacts 5, 6 open, the load circuit is opened as is also the resetting current circuit. Assuming that the contacts separate quickly, the flow of the resetting circuit is thus limited to a relatively short period, and, even though it be of a value appreciably higher than the control current, no damage to the coil 1 will result.

Thus it will be seen that the particular relay circuit described is of the pulsing or periodic closing type as the energization of the load device 9 and the resetting of the relay moving system is designed to take place alternately so long as the current output of the control current source 3 is within the range corresponding to a closure of the relay contacts 5, 6.

The elements of the instrument relay so far introduced and the circuit controlled thereby are all well known and are described in my previously issued Patent No. 2,346,589.

This application is directed to an improved structural arrangement of the pointer and movable contact carried thereby which will assure quick and positive separation of the relay contacts 5, 6 even under extremely adverse conditions to the end that the resetting current pulse will not be unduly prolonged.

As previously explained, the objective is attained by providing a pointer construction such as will permit the moving system to gain an initial momentum in the contact resetting direction upon the application of the resetting current to the coil thus developing a relatively high order of potential energy which is applied suddenly at a point close to the contacts, as distinguished from the present conventional practice of applying the counter, contact separating force through the pointer from the instant that the resetting current is applied to the coil which gives rise to a rather slow and far less effective start of the moving system.

As shown in Figs. 1-5, pointer 4 carrying the contact 5 is made quite thin and relatively flexible so as to impose a negligible amount of restraining force on coil 1 as the latter initiates its motion in the contact resetting direction. The pointer may be mounted separately on the coil staff 12 or, as illustrated, can be attached such as by spot welding to a radially aligned reset arm 13 that is mounted upon staff 12 for rotation with the coil. Arm 13 is relatively stiff as compared with pointer 4 and the attachment between the two is confined to an area immediately adjacent the staff end by bending arm 13 slightly in a direction normal to the plane of pointer rotation for the purpose of permitting pointer 4 to undergo an initial and comparatively unrestrained deflection throughout substantially its entire length when the resetting current is first applied. Mutually perpendicular extensions 13a on arm 13 are provided and these carry the usual adjustable weights 14 for balancing the moving system.

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The outer end of reset arm 13 terminates in a striker 13b extending generally parallel to the coil axis into the plane of movement of pointer 4 so as to strike the latter a sudden blow at a point immediately below contact member 5. Although a short straight rod section would be satisfactory as a striker, I prefer that it be given a curvature concave in the direction of pointer 4 so as to partially encircle the latter as shown clearly in Fig. 3 and thereby prevent the striker from sliding past the pointer upon striking it.

If desired, the striker may be modified as indicated at 13c in Fig. 4 to completely encircle the pointer shaft 4.

Now when the resetting current is first applied to coil 1, the latter and arm 13 will rotate for a few degrees in a counter clockwise direction and acquire an appreciable angular momentum practically unimpeded by any counter torque acting through the pointer shaft 4 which flexes freely as shown in Fig. 5. The outer end of pointer 4 which in the meantime has remained practically stationary is now struck a comparatively hard and sudden blow by striker 13b quickly forcing the pointer carried contact 5 away from stationary contact 6.

By so transferring the point of application of the contact separating force from the coil axis radially to a point immediately adjacent the contact member and, in addition, permitting the moving system including the reset arm to acquire an appreciable angular momentum, it should now be evident that a far more efficient use is made of the counter contact-reset torque than has been possible heretofore.

In the embodiment shown in Figs. 6-8 the auxiliary striker arm is omitted and the pointer shaft 15, which is relatively stiff as compared with pointer 4 of the previously described construction, is provided with a flexible helical coil section 15a located comparatively close to the movable contact 16. The upper and lower ends of coil 15a preferably include a few tight turns 15b for firm attachment to the upper and lower pointer sections 15c, 15d but other modes of attachment can of course be employed.

The function of the flexible coil section 15a as with the Fig. 1 construction is to allow the moving system to gain an initial angular momentum, the potential energy of which is then applied suddenly as a contact separating force close to the contacts.

When the resetting current pulse is initially applied to coil 1, the helical section 15a will at first yield quite freely in the plane of movement of pointer shaft 15 and move to the position shown in Fig. 7. The initial deformation of the helical pointer section 15a will cause the outer end of the pointer and contact member 16 to turn and slide downwardly at an angle with respect to the rounded magnetized contact member 17 but the force required for this is negligible compared with that required to finally overcome the attracting magnetic forces and hence the lower section 15d of the pointer and the remainder of the moving system will gain an appreciable momentum in the contact reset direction during the initial movement of the assembly from the position shown in Fig. 6 to that shown in Fig. 7. As the parts reach the Fig. 7 position, however, the resistance of helical section 15a to deformation undergoes a rather abrupt increase with the result that section 15a stiffens materially and the potential counter torque of the moving system is transmitted suddenly through it to contact member 16,

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as shown in Fig. 8 causing it to pull quickly and with comparatively great force away from the magnetized contact member 17.

If desired, the flexible helical section 15a of Fig. 6 can be replaced with a short straight pointer section 18a, as shown in Fig. 9, the section being appropriately reduced in areal dimensions as compared with the area of the lower and upper pointer sections 18c, 18b so as to give it the necessary degree of flexibility in the plane of pointer motion and thus permit the moving system to gain the essential initial momentum.

Figs. 10-12 illustrate still a third form of the invention that may be said to combine the basic features of the two previously described embodiments. Here, pointer 19, made of relatively stiff material, is seen to be interrupted at a point immediately below the movable contact member 21. The lower end of the upper pointer section 19b carrying contact member 20 is secured at 22 to the upper end of a helical coil 23 made from a material more flexible than that from which pointer 19 is made. Coil 23 which surrounds an appreciable portion of the lower pointer section 19c below the point-of-break 19d is of such diameter as to permit a considerable lateral movement therein of the pointer section 19c, and the lower end of the coil is secured at 24 to the latter.

When the resetting current pulse is first applied to coil 1, coil 23 yields quite freely as in the case of the construction shown in Figs. 6-8, this being accompanied by a slight turning and sliding movement of contact 20 with respect to the stationary magnetized contact 21, and thus permits the lower pointer section 19c and the remainder of the moving system to gain an initial angular momentum in the contact reset direction prior to reaching the position shown in Fig. 11. When the latter position is reached the upper end of the lower pointer section 19c strikes against the side of the coil 23 giving it a sudden and hard blow as shown in Fig. 12 which is then most effective to quickly overcome the magnetic attractive force between contacts 20, 21 as well as any additional contact attractive forces which may arise as a result of contact pitting.

In conclusion, I wish it to be understood that while several different embodiments of the invention have been described and illustrated, still other modifications may be adopted by those skilled in the art without departing from the spirit and scope of the inventive principles as defined in the appended claims.

I claim:

1. In an instrument type relay, a moving system including rotatable coil means adapted to be connected to a source of control current, contact arm means rotatable with said coil, a stationary contact, a movable contact carried by said arm means for engagement with said stationary contact, one of said contacts being of magnetic material and the other of magnetized material to assure firm engagement therebetween, means for applying a counter torque to said moving system to develop a force for resetting said contacts, and means associated with said contact arm means for suddenly applying said force to said contact arm means at a point close to said movable contact subsequent to an initial and substantially unrestrained angular deflection of said moving system in said contact reset direction.

2. In an instrument type relay, a moving system including rotatable coil means adapted to be connected to a source of control current, contact arm means rotatable with said coil, a sta-

tionary contact, a movable contact carried by said arm means for engagement with said stationary contact, one of said contacts being of magnetic material and the other of magnetized material to secure firm engagement therebetween, means developing a momentum in said moving system in the contact reset direction, and means converting said momentum into an impact force against said contact arm means in the reset direction subsequent to an initial and substantially unrestrained angular deflection of said moving system in said contact reset direction.

3. In an instrument type relay, a moving system including rotatable coil means adapted to be connected to a source of control current, contact arm means rotatable with said coil, a stationary contact, a contact carried by said arm means for engagement with said stationary contact, one of said contacts being of magnetic material and the other of magnetized material to assure firm engagement therebetween, resetting means rotatable with said contact arm means effective to permit said moving system to gain an initial and substantially unrestrained angular momentum in the contact reset direction upon the application of a counter torque to said system while said contacts remain engaged and thereafter to apply a contact separating force to said movable contact, and means for developing said counter torque.

4. In an instrument type relay, a moving system including rotatable coil means adapted to be connected to a source of control current, a contact arm rotatable with said coil, a stationary contact, a contact carried by said arm for engagement with said stationary contact, one of said contacts being of magnetic material and the other of magnetized material to assure firm engagement therebetween, said arm being relatively flexible in the plane of movement thereof to permit said moving system to gain an initial angular momentum in the contact reset direction upon the application of a counter torque to said system, means for developing said counter torque, and a relatively stiff reset arm rotatable with said coil, said reset arm including a striker element disposed in the plane of movement of said contact arm and spaced therefrom for imparting to said contact arm a sudden blow close to said movable contact following a predetermined angular travel of said moving system in the contact reset direction.

5. An instrument relay as defined in claim 4 wherein said striker partially surrounds said contact arm.

6. An instrument relay as defined in claim 4

wherein said striker completely surrounds said contact arm.

7. In an instrument type relay, a moving system including rotatable coil means adapted to be connected to a source of control current, a contact arm rotatable with said coil, a stationary contact, a contact carried by said arm for engagement with said stationary contact, one of said contacts being of magnetic material and the other of magnetized material to assure firm engagement therebetween, said arm being relatively stiff except for a section thereof adjacent said movable contact and which section is relatively flexible in the plane of movement of said arm to permit said moving system to gain a substantially unrestrained initial momentum in the contact reset direction upon an application of a counter torque to said moving system, and means for developing said counter torque.

8. An instrument type relay as defined in claim 7 wherein said flexible section is constituted by a helical coil.

9. In an instrument type relay, a moving system including rotatable coil means adapted to be connected to a source of control current, a contact arm rotatable with said coil, a stationary contact, a contact carried by said arm for engagement with said stationary contact, one of said contacts being of magnetic material and the other of magnetized material to assure firm engagement therebetween, said arm being relatively stiff and divided axially into upper and lower sections at a point close to said movable contact, a relatively flexible helical coil interconnecting said upper and lower arm sections and which functions to permit said lower arm section and the remainder of said moving system to gain an initial angular momentum in the contact reset direction upon the application of a counter torque to said system, said coil also surrounding a portion of said lower arm section below its upper end and being spaced radially therefrom to permit an initial relative motion therebetween during the reset motion, and means for developing said counter torque.

ANTHONY H. LAMB.

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