

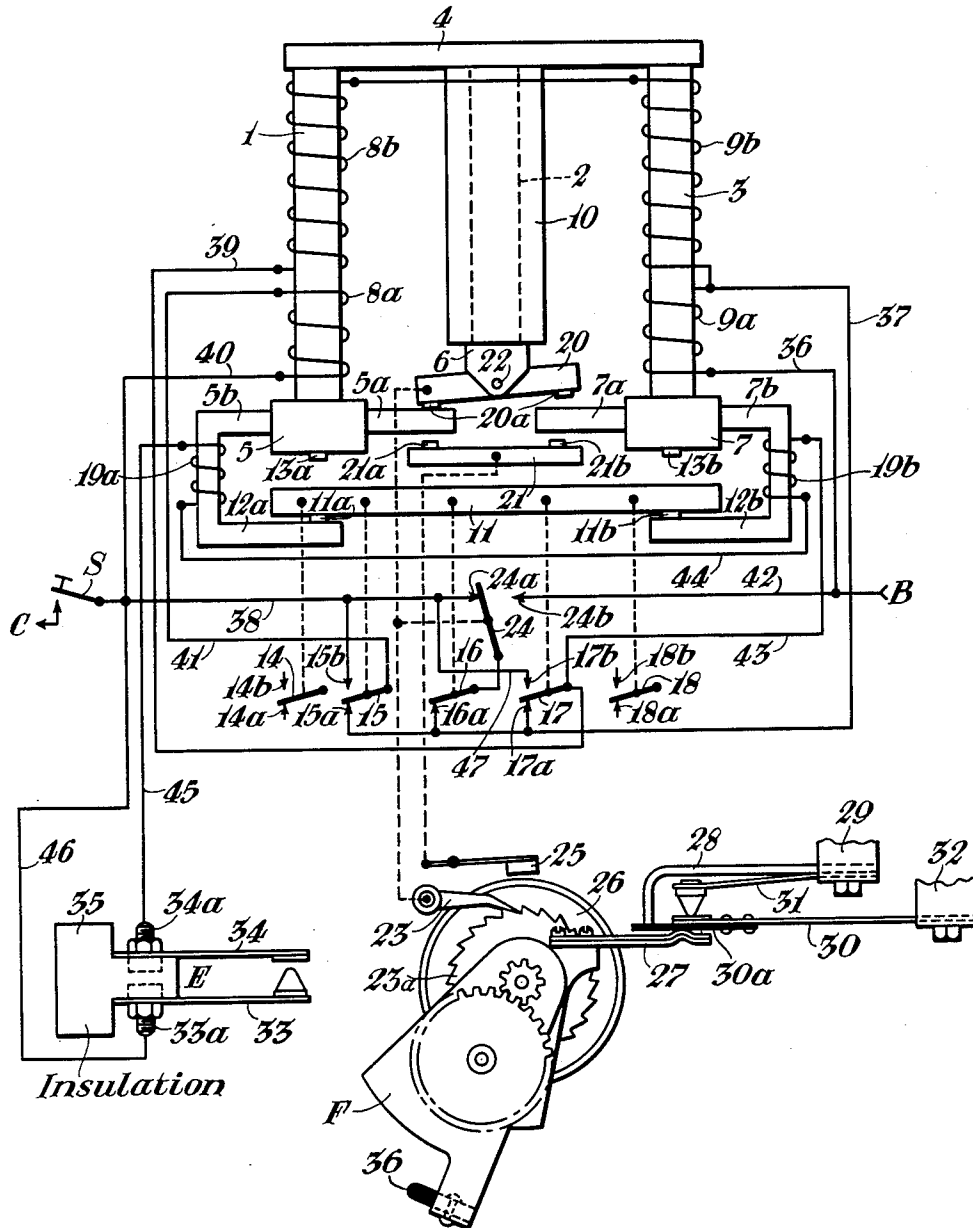
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ELECTRIC RELAYS

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ELECTRIC RELAYS

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My invention relates to electric relays, and particularly to relays of the type comprising a contact which becomes closed at the expiration of a time interval of relatively long duration after the relay becomes energized.

There is shown and described in Letters Patent of the United States No. 1,966,965 granted to Branko Lazich and myself on July 17, 1934, for Electrical Relays, a time element relay having two operating windings, two holding windings and two auxiliary windings, which are respectively energized at appropriate times during an operation of the relay. The relay includes a timing contact E which is closed after a predetermined interval following energization of the relay and which controls a holding circuit including the holding windings and the auxiliary windings, although the latter are not functioning during the holding phase of the relay operation. The relay also includes a main armature which operates additional contacts upon closure of the timing contact.

One object of my invention is to provide an improved relay of the type described in the Lazich et al. patent.

Another object is to provide improved operating circuits for such a relay.

I accomplish the foregoing and other objects of my invention by revising the operating circuits of the Lazich relay so that the circuit for the holding windings is controlled by a contact operated by the main armature rather than by the timing contact. Furthermore, the auxiliary windings are shunted, and therefore deenergized, during the holding phase of relay operation. These results are accomplished without increasing the number of contact fingers required.

The single figure of the drawing is a view partly diagrammatic and partly in elevation, showing one form of relay embodying my invention.

The relay is illustrated diagrammatically in the present drawing, and since a full description of the relay may be had by reference to the above-identified patent, it is believed that for purposes of the present application the following brief description will be sufficient.

As will be seen from an inspection of the drawing, the relay comprises a core structure consisting of three parallel legs 1, 2, and 3 connected together at one end by a backstrap 4, and provided at the other end with pole pieces 5, 6, and 7, respectively. The leg 1 is provided with an operating winding 8a and a holding winding 8b, which windings in actual practice are wound into a single coil, and the leg 2 is similarly pro-

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vided with an operating winding 9a and a holding winding 9b, which windings in actual practice are also wound into a single coil. The middle leg 2 is surrounded by an electrically conductive sleeve 10, the function of which will become apparent as the description proceeds. The pole piece 5 is provided with two extensions 5a and 5b, and the pole piece 7 is likewise provided with two extensions 7a and 7b. The extensions 5a and 7a, as shown in the drawing, extend laterally toward each other, but in actual practice these extensions project rearwardly from the pole pieces to a point opposite the middle leg 2, which latter leg is offset rearwardly from the legs 1 and 3. The extensions 5b and 7b are made U-shaped for a purpose which will appear presently and are provided with auxiliary bucking windings 19a and 19b, the purpose of which will also appear presently.

The relay also comprises a main tractive armature 11, an oscillatable timing armature 20, and a clutch armature 21. The main tractive armature 11 is biased by gravity to a retracted position in which nonmagnetizable stops 11a and 11b that are secured to the underside of the armature rest against pole faces 12a and 12b formed on the extensions 5b and 7b, respectively, but is adapted to be at times moved against the action of gravity to an attracted position in which the armature engages nonmagnetic stops 13a and 13b provided on the underside of the pole pieces 5 and 7, respectively. The oscillatable armature 20 is pivotally supported by means of a pivot pin 22 between bifurcations which are formed in the pole piece 6, and is arranged to swing toward one or the other of the pole piece extensions 5a and 7a, nonmagnetic stops 20a being attached to the armature to prevent the armature from coming into actual contact with the pole piece extensions. The clutch armature 21 is biased by gravity to a position in which it is separated from the pole piece extensions 5a and 7a by means of air gaps, but is adapted to be moved, when the relay becomes energized, to a position in which nonmagnetic stops 21a and 21b secured to this armature engage the pole piece extensions 5a and 7a.

The main armature 11 actuates a plurality of contact fingers 14, 15, 16, 17, and 18 which, when the armature occupies its retracted position in which it is shown in the drawing, engage fixed back contact members 14a, 15a, 16a, 17a, and 18a, respectively, to close back contacts 14—14a, 15—15a, 16—16a, 17—17a, and 18—18a. When, however, the armature 11 occupies its attracted

position, the fingers 14, 15, 17, and 18 then engage fixed front contact members 14b, 15b, 17b, and 18b, to close front contacts 14—14b, 15—15b, 17—17b, and 18—18b. The back contacts 15—15a, 16—16a, and 17—17a and the front contacts 15—15b and 17—17b control the operating circuits which energize the various windings of the relay in a manner which will be described more fully hereinafter. The contacts associated with fingers 14 and 18 control circuits external to the relay and not shown in the drawing. These are the circuits which the relay is employed to open or close a predetermined time after closure of a manual starting switch S.

The auxiliary armature 20 actuates a double-throw contact finger 24 to close a contact 24—24a or 24—24b according as the armature 20 occupies the extreme position in which it is shown in the drawing, or its opposite extreme position, respectively. The contacts 24—24a and 24—24b control the supply of energy to the windings 8a and 9a in such manner that when the manually operable starting switch S is closed to energize the relay, and the main armature 11 occupies the position shown, the armature 20 will be made to oscillate as will appear more fully hereinafter.

The armature 20 also actuates a pawl 23 which cooperates with a ratchet wheel 23a in such manner that oscillation of the armature 20 will cause a step-by-step rotation of the ratchet wheel in a clockwise direction. The ratchet wheel 23a is operatively connected with a planetary arm F in such manner that when a clutch 25, which is operatively connected with the clutch armature 21, is engaging a clutch wheel 26, rotation of the ratchet wheel 23a will cause the arm F to rotate in a clockwise direction, but that, when the clutch 25 is out of engagement with the clutch wheel, the arm F is then free to rotate in a counterclockwise direction, due to the bias of gravity, to a position in which a strip 27, which is secured to the arm F, engages an insulating member 30a, secured to a contact finger 30, and moves the insulating member into engagement with a fixed stop 28 and the finger 30 into engagement with another contact finger 31. The stop 28 and finger 31 are secured to a suitable supporting bracket 29, while the finger 30 is secured to a similar bracket 32. The two fingers 30 and 31 together form a checking contact, the function of which is to indicate when the arm F occupies the position to which it is biased.

The contact arm F controls a contact E comprising two spaced fingers 33 and 34 attached by means of studs 33a and 34a to a block 35 of insulating material. The contact E is arranged to be closed, in response to clockwise rotation of the arm F, by means of an insulating piece 36 which is secured to the arm F.

Operation

When the parts are in the positions shown in the drawing, switch S is open and the windings 8a, 8b, 9a, 9b, 19a and 19b are all deenergized. The main armature 11 therefore occupies its retracted position so that contacts 14—14a, 15—15a, 16—16a, 17—17a, and 18—18a are all closed, and contacts 14—14b, 15—15b, 17—17b, and 18—18b are all open. The timing armature 20 is swung toward extension 5a of pole piece 5, and normal contact 24—24a is therefore closed, while reverse contact 24—24b is open. The contact arm F is held by gravity in its normal position, so that contact 30—31 is closed and contact E is open.

I will now assume that with the parts in the positions just described, switch S becomes closed. The closing of this switch completes a circuit for the winding 9a passing from terminal B of a suitable source of current (not shown in the drawing) through wire 36, winding 9a, wire 37, contact 16—16a, contact 24—24a, wire 38 and switch S to the other terminal C of the source. Windings 8b and 9b are shunted by a connection which may be traced from the lower terminal of winding 8b through wire 39, contact 17—17a and wire 37 to the lower terminal of winding 9b, and winding 8a is shunted by a connection which may be traced from the lower terminal of winding 8a through wires 40 and 38, contacts 24—24a, 16—16a, and 15—15a, and wire 41 to the upper terminal of winding 8a. As a result of energization of winding 9a, auxiliary armature 20 is swung toward extension 7a of pole piece 7, and the clutch armature 21 is attracted to extensions 5a and 7a of the pole pieces 5 and 7. The main armature 11, however, is held away from the pole pieces 5 and 7 under these conditions because the windings 19a and 19b on the pole piece extensions 5b and 7b are deenergized, and the reluctance of the path to the main armature through the magnetic structures of the pole piece extensions 5b and 7b for the flux set up by winding 9a is lower than the reluctance of the path through the air gaps between the pole pieces 5 and 7 and the main armature, and hence more flux therefore reaches the main armature through the pole piece extensions than across the air gap from the pole pieces 5 and 7. It follows that the tractive force exerted to lift the armature 11 toward the pole pieces 5 and 7 is less than the combined force of gravity and the effect of the flux through the pole piece extensions 5b and 7b. The contacts 14—14a, 15—15a, 16—16a, 17—17a, and 18—18a controlled by the main armature therefore remain closed even though winding 9a is now energized.

When the auxiliary armature 20 is swung toward extension 7a of pole piece 7, normal contact 24—24a becomes opened and reverse contact 24—24b becomes closed. Since contacts 16—16a and 17—17a are still closed, the closing of contact 24—24b completes a shunt connection across winding 9a. This connection may be traced from the lower terminal of winding 9a through wires 36 and 42, contact 24—24b, contact 16—16a and wire 37 to the upper terminal of winding 9a. The field set up by winding 9a commences to decay. Due, however, to the snubbing effects of the circuit for winding 9a, and of the conductive sleeve 10, this decay is comparatively slow. The opening of contact 24—24a in the meantime has removed the shunt from winding 8a, thus allowing this winding to become energized upon closure of contact 24—24b, through a circuit which may be traced from terminal B through wire 42, contacts 24—24b, 16—16a, 15—15a, wire 41, winding 8a, wire 40, and switch S to terminal C. The growth of the flux set up by this latter winding 8a is comparatively slow, however, due to the sleeve 10 on leg 2 and the shunted windings 8b and 9b, but, after an interval of time, the torque exerted on armature 20 by this flux overbalances the torque exerted on armature 20 by the decaying flux in winding 9a, and armature 20 then swings back toward extension 5a of pole piece 5. This motion first opens contact 24—24b and then closes contact 24—24a. The main armature 11 is still held away from the pole pieces 5

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and 7 during this movement of the armature 20 for the reasons pointed out hereinbefore so that contacts 14—14a, 15—15a, 16—16a, 17—17a, and 18—18a controlled by armature 11 are still closed, and winding 9a therefore again becomes energized and winding 8a again becomes shunted. The shunt connection across windings 8b and 9b is not disturbed. The field of winding 9a then slowly builds up, and the field of winding 8a slowly decays, this decay being retarded by the self inductance of winding 8a and by the sleeve 10. It will therefore be seen that timing armature 20 is positively swung to and fro as long as switch S is closed and the windings 19a and 19b remain deenergized, and it will also be clear that a considerable interval of time elapses between armature movements. It should be pointed out that this time interval is substantially independent of fluctuations of the electromotive force in the energy supply because the auxiliary armature is acted upon by two opposing forces both of which increase or decrease as the electromotive force of the energy supply increases or decreases.

Each time the auxiliary armature 20 is swung toward pole piece extension 7a, the pawl 23 rotates the ratchet wheel 23a through a small arc, and since the clutch 25 is now held in engagement with the clutch wheel 26 by the clutch armature 21, the rotation of the ratchet wheel is transmitted through the gearing of the planetary arm F to this arm, thus causing the arm to be rotated in a clockwise direction in response to the rotation of the ratchet wheel. As soon as the contact arm has been rotated through a small arc, the resultant movement of the strip 27 permits contact finger 30 to move out of engagement with contact finger 31, thereby opening the contact 30—31. After the armature 20 oscillates a predetermined number of times, the arm F moves the insulating piece 36 into engagement with the contact finger 33 and deflects it against contact finger 34, thereby closing contact E.

When contact E becomes closed, if contact 24—24b is then closed, or as soon thereafter as contact 24—24b becomes closed, current is supplied to the windings 19a and 19b over a circuit which may be traced from terminal B through wire 42, contact 24—24b, contacts 16—16a, 17—17a, wire 43, winding 19b, wire 44, winding 19a, wire 45, contact E, wire 46 and switch S to terminal C. Windings 19a and 19b are then in parallel with winding 8a. The windings 19a and 19b are connected in this circuit in such manner that the fluxes created in the extensions 5b and 7b of the pole pieces 5 and 7 thread these extensions in the opposite direction from the fluxes which thread these extensions due to current in either of the windings 8a or 9a, and the parts are so proportioned that the magnitude of the flux in the extensions 5b and 7b due to the current in the windings 19a and 19b is sufficiently great that the flux which threads the armature 11 through the air gaps between the armature 11 and the pole pieces 5 and 7 under these conditions exerts a torque on the armature which causes the armature to swing toward the pole pieces 5 and 7. Shortly after the armature 11 starts to swing toward the pole pieces 5 and 7, contacts 14—14a, 15—15a, 16—16a, and 18—18a are opened but contact 17—17a is adjusted to remain closed until the armature has moved a short distance beyond the point in its upward travel at which the other contacts open.

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When contacts 15—15a and 16—16a are open, winding 8a is deenergized and the shunt connection for winding 9a, which is normally completed at contact 16—16a when contact 24—24b is closed, is opened. Winding 9a is then supplied with current in series with the windings 19a and 19b over contact 17—17a, the circuit being from terminal B through wire 36, winding 9a, wire 37, contact 17—17a, wire 43, winding 19b, wire 44, winding 19a, wire 45, contact E, wire 46, and switch S to terminal C. Winding 9a, therefore, becomes energized and supplies flux to the armature 11 in place of winding 8a. The resistance of the windings 19a and 19b will usually be considerably less than the resistance of the winding 9a, so that the insertion of windings 19a and 19b in series with winding 9a does not materially reduce the voltage across winding 9a nor the current through it. Hence the flux due to winding 9a under these conditions is only slightly less than the magnitude of the flux which was supplied to armature 11 due to current in winding 8a, and it will be apparent, therefore, that the opening of contacts 15—15a and 16—16a has very little effect on the torque exerted on the armature 11 tending to move the armature toward the pole pieces 5 and 7. As soon as winding 8a becomes deenergized and winding 9a becomes energized in the manner just described, auxiliary armature 20 stops oscillating, and this armature is then held in the position in which its contact 24—24b is closed. When contact 17—17a opens, the shunt connection which was previously closed for windings 8b and 9b at this contact is opened, and the windings 8a, 8b, 9b, 19a, and 19b in series are then all supplied with current from the terminals B and C of the source over contact E and switch S so that these windings are all energized. The windings 8b and 9b are preferably constructed to have a comparatively high resistance in order to limit to a low value the current supplied to the relay after these windings become energized. When armature 11 has completed its upward stroke, contacts 14—14b, 15—15b, 17—17b, and 18—18b become closed. Closure of contact 15—15b completes a shunt connection for winding 8a which may be traced from its upper terminal through wire 41, contact 15—15b, and wires 38 and 40 to its lower terminal. Closure of contact 17—17b completes a shunt connection for the circuit branch which includes windings 19a and 19b and switch E. This shunt may be traced from switch S through wire 38, wire 47, contact 17—17b and wire 43 to the upper terminal of winding 19b.

As long as switch S remains closed, windings 8b, 9b and 9a remain energized through a circuit which may be traced from terminal B through wire 36, windings 9a, 9b, 8b, wire 39, contact 17—17b, wires 47 and 38, and switch S to terminal C. This holding circuit is independent of any contact other than switch S and contact 17—17b, which latter contact is held closed by armature 11. In particular, the holding circuit is independent of contact E and therefore of the clutch 25 and the timing mechanism operated by oscillatable armature 20. Opening of contacts E due to vibration at the contacts or to any malfunctioning of the timing mechanism is thereby prevented from affecting the position of the main armature and the contact fingers 14 and 18.

When switch S is opened to deenergize the relay, the neutral armature 11 drops away from the pole pieces 5 and 7, thereby opening contacts 14—14b, 15—15b, 17—17b, and 18—18b

and closing contacts 14—14a, 15—15a, 16—16a, 17—17a, and 18—18a. Furthermore, the clutch armature 21 drops away from the extensions 5a and 7a of the pole pieces 5 and 7, respectively, thereby permitting the contact arm F to return by gravity to its normal position. When the contact arm returns to its normal position, contact E is opened and contact 30—31 becomes closed. When contact 30—31 becomes closed, the parts of the relay are then restored to their normal positions in which they are illustrated in the drawing.

Although I have herein shown and described only one form of electric relay embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. A time element relay comprising two operating windings and a holding winding, a timing armature oscillatable by alternate energization of said operating windings, energizing circuits for said operating windings including a double-throw contact finger operated by said timing armature and effective to alternately close said circuits, a timing contact, timing means operated by oscillation of said timing armature and effective after a predetermined number of oscillations thereof to close said timing contact, a main armature, an auxiliary winding effective when energized in conjunction with one of said operating windings to cause said main armature to move from a retracted position to an attracted position, an energizing circuit for said auxiliary winding including said timing contact, at least three contact fingers operated by said main armature, back and front contacts associated with one of said three fingers, said one finger being effective when engaging its back contact to complete a shunt for said holding winding and said auxiliary winding energizing circuit and when engaging its front contact to complete a shunt for said auxiliary winding and an energizing circuit for said holding winding independent of said timing contact, said one finger being effective when moving between its back and front contacts when said timing contact is closed to open both said shunts so that said auxiliary and holding windings are then energized in series over said timing contact, back and front contacts associated with a second of said three fingers, said second finger being effective when engaging its back contact to complete the energizing circuit for one of said operating windings and when engaging its front contact to complete a shunt connection for said one operating winding, and a back contact associated with the third of said three fingers and connected in series with said double-throw contact finger in both said operating winding energizing circuits.

2. A time element relay comprising two operating windings and a holding winding, a timing armature oscillatable by alternate energization of said operating windings, energizing circuits for said operating windings including a double-throw contact finger operated by said timing armature and effective to alternately close said circuits, a timing contact, timing means operated by oscillation of said timing armature and effective after a predetermined number of oscillations thereof to close said timing contact, a main armature, an auxiliary winding effective when ener-

gized in conjunction with one of said operating windings to cause said main armature to move from a retracted position to an attracted position, an energizing circuit for said auxiliary winding including said timing contact, a plurality of contact fingers operated by said main armature, back and front contacts associated with one of said plurality of fingers, said one finger being effective when engaging its back contact to complete a shunt for said holding winding and said auxiliary winding energizing circuit and when engaging its front contact to complete a shunt for said auxiliary winding and an energizing circuit for said holding winding independent of said timing contact, said one finger being effective when moving between its back and front contacts when said timing contact is closed to open both said shunts so that said auxiliary and holding windings are then energized in series over said timing contact, and back and front contacts associated with a second of said plurality of fingers, said second finger being effective when engaging its back contact to complete the energizing circuit for one of said operating windings and when engaging its front contact to complete a shunt connection for said one operating winding.

3. A time element relay comprising two operating windings and a holding winding, a timing armature oscillatable by alternate energization of said operating windings, energizing circuits for said operating windings including a double-throw contact finger operated by said timing armature and effective to alternately close said circuits, a timing contact, timing means operated by oscillation of said timing armature and effective after a predetermined number of oscillations thereof to close said timing contact, a main armature, an auxiliary winding effective when energized in conjunction with one of said operating windings to cause said main armature to move from a retracted position to an attracted position, an energizing circuit for said auxiliary winding including said timing contact, a plurality of contact fingers operated by said main armature, back and front contacts associated with one of said plurality of fingers, said one finger being effective when engaging its back contact to complete a shunt for said holding winding and said auxiliary winding energizing circuit and when engaging its front contact to complete a shunt for said auxiliary winding and an energizing circuit for said holding winding independent of said timing contact, and a back contact associated with a second of said plurality of fingers, said second finger being effective when engaging its back contact to complete the energizing circuit for said one operating winding.

4. A time element relay comprising two operating windings and a holding winding, a timing armature oscillatable by alternate energization of said operating windings, energizing circuits for said operating windings including a double-throw contact finger operated by said timing armature and effective to alternately close said circuits, a timing contact, timing means operated by oscillation of said timing armature and effective after a predetermined number of oscillations thereof to close said timing contact, a main armature, an auxiliary winding effective when energized in conjunction with one of said operating windings to cause said main armature to move from a retracted position to an attracted position, an energizing circuit for said

auxiliary winding including said timing contact, a plurality of contact fingers operated by said main armature, and back and front contacts associated with one of said plurality of fingers, said one finger being effective when engaging its back contact to complete a shunt for said holding winding and said auxiliary winding energizing circuit and when engaging its front contact to complete a shunt for said auxiliary winding and an energizing circuit for said holding winding independent of said timing contact.

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