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**Section 1 – Introduction**

**Warning:** Before any adjustments, servicing parts replacement or any other act is performed requiring physical contact with the electrical working components or wiring of this equipment, the power supply must be disconnected.

**Warning:** The vacuum interrupter integrity test (as described in Section 11) should be performed before the high-voltage vacuum contactor is energized for the first time and each time the contactor is returned to service after maintenance, adjustment, or repair. Otherwise this test should be performed annually. Failure to perform this test may result in serious injury or death.

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**General**

These instructions cover Vacuum Limitamp High-Voltage Contactors. These contactors are designed for equipment used in starting ac motors with line voltages from 1000 Volts to a maximum of 7200 Volts, transformer feeders, and other high-voltage control equipment.

These contactors are designed to provide long, trouble-free service with only a minimal amount of maintenance.

These contactors can be identified by their catalog number. An outline of the catalog number nomenclature is shown in Table 1.

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**Table 1. Vacuum contactor catalog number system.**

<table>
<thead>
<tr>
<th>Basic Number = CR193</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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</thead>
<tbody>
<tr>
<td><strong>Current Rating</strong></td>
<td>B = 400A, Bolt-in</td>
<td>C = 800A, Bolt-in</td>
<td>D = 400A, Stab-in</td>
<td>E = 800A, Stab-in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Coil Voltage</strong></td>
<td>Code</td>
<td>Contactor Main Coil Voltage</td>
<td>Unlatch Coil Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>------</td>
<td>---------------------------</td>
<td>---------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>000</td>
<td>No Coil</td>
<td>No Latch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>110/115VDC</td>
<td>No Latch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>910</td>
<td>110/115VDC</td>
<td>110/115VDC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>924</td>
<td>110/115VDC</td>
<td>24VDC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>948</td>
<td>110/115VDC</td>
<td>48VDC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>950</td>
<td>110/115VDC</td>
<td>230/250VDC</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Auxiliary Interlock Location**

U or Blank = Interlocks on Either Side of Contactor
L = Left Side of Contactor Only
R = Right Side of Contactor Only

**Assembly Style**

A = Stab In
B = Bolt In

**Normally Closed (N.C.) Auxiliary Contacts**

00 = 0 N.C. Contacts
05 = 5 N.C. Contacts
07 = 7 N.C. Contacts
20 = 20 N.C. Contacts

**Latch Mechanism**

L0 = No Latch
L1 = Latch Electrical Close and Open
L2 = Latch Electrical Close and Open with Manual Release

**Normally Open (N.O.) Auxiliary Contacts**

00 = 0 N.O. Contacts
05 = 5 N.O. Contacts
07 = 7 N.O. Contacts
20 = 20 N.O. Contacts

**Note:** Sum of N.O. and N.C. interlocks cannot exceed 20. Interlock block assembly has five (5) contacts/assembly. Maximum of four (4) block assemblies per contactor can be provided. Other combinations of N.O. and N.C. are possible. Change arguments to meet arrangement required.
Section 2 – Description

Principle of Operation
These contactors are magnetically operated by means of a DC coil. Energization of this coil causes the contacts inside the sealed vacuum interrupter to close and establish the power circuit. When this coil is de-energized two armature return springs force the moving armature to open the vacuum interrupter contact tips. As these tips open, the current in the power circuit is interrupted at the first current zero crossing. This extremely quick interruption reduces the arc energy and results in low contact wear.

Construction
The main components of these contactors are as follows: a one-piece, molded-glass, polyester case; a molded-glass, polyester moving armature; three vacuum interrupters; a coil and magnet; and a molded-glass, polyester terminal support bar.

These contactors can be fitted with up to twenty auxiliary contacts in any combination of normally open and normally closed. These contactors are housed in a clear, plastic housing for easy contact inspection.

Vacuum Limitamp Contactors are built with metric hardware so that the contactor line can be used throughout the world.

Vacuum Interrupter Contact Resistance
GE does not have a recommendation for the vacuum interrupter contact resistance because this type of test can yield confusing results. If this type of test is done it should only be used as a trending type tool to indicate that the contacts in the interrupter may be showing wear. The test should be done with a test instrument that induces a minimum of 50A current through the vacuum interrupter to reduce variability in the test results.

The best method for testing the vacuum interrupters is to follow the contact wear test described in these instructions and to conduct vacuum integrity test.

Since the contact tips in a vacuum interrupter are sealed inside a vacuum chamber the tips are not subject to the normal oxidation and corrosion that can result on contact exposed to air.

Section 3 – Installation

General
All Vacuum Limitamp Contactors are subjected to thorough inspection and testing prior to packaging for shipment.

Observe the following precautions before applying power to a contactor for the first time.

1. Remove all packing materials that were used to protect the contactor in transit.
2. Carefully inspect all parts of the contactor for damage.
3. Remove any protective grease or oil which may be on the magnet pole faces, as the grease could collect dust and dirt, thus causing a sticking of the magnet.
4. Ensure that all parts of the contactor are clean. Accumulations of dust and dirt on high-voltage equipment can cause failures.
5. Manually operate the moving armature of the contactor to see that all parts operate freely.
6. Operate the contactor electrically under no load conditions by applying rated coil voltage to the coil terminals. Note that these contactors use DC operated coils. When the contactor has completely closed, the voltage applied to the coil must be reduced to approximately 25 percent of the rated voltage to prevent over-heating of the coil windings.
7. Perform a check on each vacuum interrupter as described in Section 11 entitled “Vacuum Interrupter Integrity Test.”
Section 4 – Maintenance

General

Vacuum Limitamp Contactors will provide long trouble-free service if given the benefit of inspection, preventative maintenance, and periodic cleaning. The frequency of the inspection periods will depend upon the operating conditions for the contactor.

Table 2 lists the adjustment tools and gages that are required to perform the inspection and adjustments as described in the following sections. See Figure 1.

Contactor gages and adjustment tools are available from the factory.

Table 2 - Contactor Gages and Adjustment Tools

<table>
<thead>
<tr>
<th>Tool Description</th>
<th>CR193B, CR193D</th>
<th>CR193C, CR193E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Wear Gage</td>
<td>55A212185G1</td>
<td>55A212185G1</td>
</tr>
<tr>
<td>Armature Setting Gage</td>
<td>55B532540P1</td>
<td>55B532547P1</td>
</tr>
<tr>
<td>Contactor Closing Tools¹</td>
<td>55A212118G2</td>
<td>55A212118G2</td>
</tr>
<tr>
<td>Interlock Set Gage</td>
<td>55A212152P1</td>
<td>55A212152P1</td>
</tr>
<tr>
<td>Gage Kit²</td>
<td>302A3900DCG1</td>
<td>302A3900DCG2</td>
</tr>
</tbody>
</table>

¹ Quantity of two required.
² Contains all gages for contactor.

Warning: Disconnect the contactor from the power supply before making any inspections or adjustments as specified in Sections 4 through 10.

Caution: Do not deviate from the instructions outlined. Do not force movement of the armature. Over travel of the contacts beyond the limits specified could cause damage to the vacuum interrupter bellows. Do not twist the movable terminal of the interrupter. Rotational twisting can cause permanent damage to the interrupter bellows. Exercise care when replacing interrupters to prevent damage which can reduce the life of the equipment and cause serious injury or death due to current leakage in the interrupter.

Inspection

During routine inspections check for the following items:

1. Loose screws, nuts, and bolts.
2. Accumulation of dust or foreign material such as coal dust, cement dust, or lamp black. These materials must be periodically removed from the contactor if inspection shows any accumulation.
   The outside surfaces of the vacuum interrupters must be wiped clean, as dust collects moisture which can cause a voltage breakdown around the outside of the interrupter.
3. Check the magnet and coil air gap setting. Refer to Section 5 "Coil Adjustment and Replacement".
4. Check each of the vacuum interrupters for contact wear. Refer to Section 6 or 8 "Contact Wear Check".
5. Check auxiliary interlock adjustment and contact wear. Refer to Section 10 "Auxiliary Interlock Adjustment and Replacement".
6. Perform a check on each vacuum interrupter as outlined in Section 11 "Vacuum Interrupter Integrity Test".
7. Check the contactor latch mechanism if applicable. Refer to Section 12 "Latch Mechanism".

Figure 1. Tools for inspection and adjustment.
Section 5 – Coil Adjustment and Replacement

Procedure for All Contactor Sizes

1. If the contactor has no latch proceed directly to Step 2. If the contactor is fitted with a latch, disconnect the unlatch coil control wires and remove the two (2) latch mounting screws and lift the latch mechanism from the contactor.

2. If the contactor coil requires replacement due to overheating or other damage follow Steps 3 through 11. If the coil does not need replacement follow Steps 9 through 11.

3. Disconnect coil terminal wires. See Figure 2.

4. Remove the three (3) coil mounting screws. See Figure 2.

5. Lift coil assembly out of contactor. See Figure 3.

6. Position the new coil into the contactor and tighten the three (3) mounting screws.

7. Close contactor manually using the contactor closing tools. See Figure 5. Ensure that the pole faces of the coil mate with the moving armature.


9. With the contactor in the open position, check the magnet and coil air gap using the armature setting gage. Insert the gage fully between the armature and the coil pole faces. The gage should be a close sliding fit. See Figure 4. If adjustment is necessary follow Steps 10 and 11. If adjustment is not required then no other checks of the coil are necessary. Proceed directly to Step 11.

10. Remove the two (2) barrel nuts at top of push-off spring rods (see Figure 4, Item C) and adjust the two (2) plastic stop nuts until the close sliding fit is obtained at the gage. Reassemble the two (2) barrel nuts and tighten them against the plastic stop nuts.

11. If the contactor is fitted with a latch mechanism, reassemble the latch and adjust as discussed in Section 12 “Latch Mechanism”.

Figure 2. Coil terminal wires and mounting screws.

Figure 3. Removal of coil assembly.
Section 6 – Contact Wear Check

CR193B and CR193D (400 Ampere Contactors)

1. Close the contactor using the contactor closing tools. See Figure 5. Do not over tighten. A single sheet of ordinary paper inserted between the armature and closing coil may be used as a helpful feeler gage to determine when the armature has just closed against the face of the coil poles.

2. Check for contact wear by inserting the “RESET” end of the contact wear gage between the lock nuts and the spacer sleeve as shown in Figure 5. If the “RESET” end of the gage CANNOT be inserted then the interrupter needs to be replaced as there is no means to adjust the interrupter. Follow steps in Section 7 to replace interrupter.

3. If the interrupter does not need to be replaced, remove the contact wear gage and the contactor closing tools.

Figure 4. Insertion of armature setting gage.

Figure 5. Checking contact wear with wear gage.
Section 7 – Interrupter Replacement

CR193B and CR193D
(400 Ampere Contactors)

The procedure below describes the steps required to replace a single interrupter. Repeat steps for each interrupter that requires replacement.

1. Remove the two (2) nuts and the spacer sleeve from the top of the interrupter drive stem. Items A and B, Figure 7.
2. Remove the six (6) screws which attach the flexible braid assemblies to the terminal support bar. Item C, Figure 8.
3. Remove the four (4) screws that attach the terminal support bar to the contact box. Item D, Figure 8. Lift the terminal support bar out of the contact box.
4. Loosen the mounting bolt at the bottom of the interrupter assembly. Item E, Figure 8.
5. Withdraw the interrupter assembly downwards from the contactor. See Figure 9.
6. Remove the contact pressure spring and guide bearing (Items H and I, Figure 10) from the interrupter. Assemble parts on new interrupter assembly.
7. Insert new interrupter assembly into the contactor. Make sure that the brass guide bearing on the interrupter is fully seated in the spherical bearing on the contactor moving armature. Be careful to not twist the interrupter shaft because this could cause damage to the internal bellows.
8. Slide the bottom mounting bolt on the interrupter into the slot in the bottom support. Tighten the mounting bolt.
9. Reassemble the spacer sleeve and one nut to the top of the interrupter drive stem. With the contactor in the OPEN position adjust the nut on the driver stem until the top of the driver stem is level with the top of the bearing support. See Figure 6.
10. Manually close the contactor using the contactor closing tools. Do not over tighten. A single sheet of ordinary paper inserted between the armature and the closing coil may be used as a helpful feeler gage to determine when the armature has just closed against the face of the coil poles.
11. On top of the interrupter assembly driver there will be a gap between the spacer sleeve and the nut. Insert the “INITIAL” end of the contact wear gage into this gap. Adjust the nut so it is snug against the gage. Assemble the second locking nut to the driver stem and lock it against the first nut. See Figure 5.
12. Remove the contact wear gage and remove the contactor closing tools.

Figure 6. Driver stem adjustment.
Figure 7. Removal of the nuts and spacer sleeve from interrupter driver stem.

Figure 8. Removal of screws attaching the flexible braid assemblies with the terminal support bar.

Figure 9. Downward removal of interrupter assembly.

Figure 10. Interrupter with contact pressure spring and guide bearing.
Section 8 – Contact Wear Check and Interrupter Reset

CR193C and CR193E
(800 Ampere Contactors)

1. Close the contactor using the contactor closing tools (Item G, Figure 11). Do not over tighten. A single sheet of ordinary paper inserted between the armature and the closing coil may be used as a helpful feeler gage to determine when the armature has just closed against the face of the coil poles.

2. Check for contact wear by inserting the “RESET” end of the contact wear gage between the spacer sleeve and the nuts on the top of the driver stem. See Figure 11. If the “RESET” end of the gage CANNOT be inserted then the interrupter needs to be reset. Follow Steps 3 through 7. If reset is not required go to Step 7. Each interrupter should be checked and reset as required.

3. Loosen the two (2) clamp block screws (Item J, Figure 12) until the alignment bushing at the bottom of the interrupter is free to rotate.

4. Using a 5/8 inch open end wrench turn the adjustment bushing to raise the interrupter until the “INITIAL” end of the contact wear gage can be inserted between the spacer sleeve and the nuts on the driver stem. See Figure 11. Do not turn the hex head bolt beneath the alignment bushing.

5. Tighten the clamp block screws (8 lb-ft) to lock the alignment bushing in place. After the clamp block screws are tightened check to see that the fit at the wear gage is snug; if not readjust the interrupter position as described in Step 4.

6. Adjacent to the interrupter is an interrupter reset indicator label. This label indicates the number of times each interrupter has been reset. Remove the appropriate portion of the peel off label. See Figure 13. If the interrupter has previously been reset two (2) times then the indicator label will show blue and red markings. If this is the case the interrupter must be replaced. Refer to Section 9 “Interrupter Replacement”.

7. Remove the contactor wear gage and the contactor closing tools.

Figure 11. Checking contact wear with wear gage.

Figure 12. Adjusting interrupter.
Section 9 – Interrupter Reset

CR193C and CR193E
(800 Ampere Contactors)

The procedure below describes the steps required to replace a single interrupter. Repeat steps for each interrupter that requires replacement.

1. Remove the two (2) nuts and the spacer sleeve from the top of the interrupter drive stem. Location A, Figure 11.
2. Remove the six (6) screws that attach the flexible braid assemblies to the terminal support bar. Location B, Figure 14.
3. Remove the four (4) screws that attach the terminal support bar to the contact box. Location C, Figure 14. Lift the terminal support bar out of the contact box.
4. Remove the two (2) clamp block screws and the clamp block from the bottom of the interrupter assembly. Items D and E, Figure 14.
5. Withdraw the interrupter assembly downwards from the contactor. See Figure 15.
6. Remove the brass guide bearing and contact pressure spring from the old interrupter assembly and place them on the new interrupter assembly.
7. Insert new interrupter assembly into the contactor. Make sure the brass guide bearing is fully seated in the spherical bearing on the contactor moving armature.
8. Reassemble the spacer sleeve and one nut to the top of the interrupter drive stem. With the contactor in the OPEN position adjust the nut on the drive stem until the top of the driver stem is level with the top of the support post. See Figure 16. Assemble the second locking nut to the driver stem and lock it against the first nut.
9. Turn the adjustment bushing (Item F on Figure 17) on the bottom of the interrupter until it is against the end of the bottom stem of the interrupter. Do not turn the hex head bolt that threads into the bottom stem of the interrupter.
10. Pull down on the body of the interrupter to seat the alignment bushing into the groove in the bottom terminal. See Figure 17.
11. Reassemble the clamp block to the bottom terminal making sure that the groove in the clamp block aligns with the alignment bushing. Partially tighten the clamp block screws.
12. Manually close the contactor using the contactor closing tools. Do not over tighten. A single sheet of ordinary paper inserted between the armature and the closing coil may be used as a helpful feeler gage to determine when the armature has just closed against the face of the coil poles.
13. Using a 5/8” open end wrench turn the adjustment bushing to raise the interrupter until the “INITIAL” end of the contact wear gage can be inserted between the spacer sleeve and the nuts on the driver stem. See Figure 18.
14. Tighten the clamp block screws (8lb.-ft.) to lock the alignment bushing in place. After the clamp block screws are tightened check to see that the fit at the wear gage is snug; if not readjust the interrupter position as described in Step 13.
15. Remove the old interrupter reset indicator label that is adjacent to the interrupter and apply new label supplied.
16. Reassemble the terminal support bar to the contactor box and attach each of the flexible braid assemblies to the support bar.
17. Remove the contactor wear gage and the contactor closing tools.
Figure 15. Downward removal of interrupter assembly.

Figure 17. Alignment bushing positioned in the bottom terminal.

Figure 16. Adjustment of driver stem during interrupter reassembly.

Figure 18. Adjustment of interrupter.
Section 10 – Auxiliary Interlock Adjustment and Replacement

Procedure for All Contactor Sizes

The procedures below describe the steps required to replace an interlock block assembly. Interlock blocks should be replaced when the following conditions exist:

• The contacts are badly pitted or burned.
• The contact tips are worn to a point where the silver facing on the tips has worn by 0.02 inches.

Note: Tarnish on the silver facings does not have to be removed because the tarnish breaks down into products that are conductive when power is applied.

1. Tag all the wires that connect to the interlock terminals and then remove. See Figure 19.
2. Remove the nut from top of interlock driver stem on the top side of the armature molding (or extension arm). Item A, Figure 19.
3. Remove the two (2) interlock mounting screws and remove the interlock from the contactor. Item B, Figure 19. Remove any extension rods, nuts, and washers that might be connected to the interlock and assemble these parts to the new interlock assembly.
4. Assemble the new interlock assembly to the contactor using its two (2) mounting screws. Install the nut on the top of the interlock driver stem but do not tighten at this time.
5. Insert the interlock set gage into the bottom of the interlock as shown in Figure 20.
6. Adjust the nuts at the armature molding (extension arm) until the moving contact carrier inside the interlock block just touches the top of the interlock set gage. See Figure 20.
7. Tighten the nuts on both the top and bottom sides of the armature molding (or extension arm). Make sure that the interlock clevis and contact carrier are not twisted as the nuts are tightened.
8. Reattach all wire to their appropriate terminal.

Figure 19. Replacement of interlock block assembly.
Figure 20. New interlock adjustment.
Section 11 – Vacuum Interrupter Integrity Test

Caution: X-ray emissions may be produced if an abnormally high voltage is applied across the open contacts of a vacuum interrupter. Do not apply a voltage that is higher than the values recommended in the test instructions.

General

This test determines the internal dielectric condition and vacuum integrity of the vacuum interrupters. Prior to performing this test the outside of the vacuum interrupters should be wiped clean of any contaminants with a non-linting cloth or industrial type wiper. During this test each vacuum interrupter should be checked individually.

Warning: The vacuum interrupter integrity test should be performed before the high voltage vacuum contactor is energized for the first time, and each time it is returned to service after maintenance, adjustment, or repair. Otherwise, this test should be performed annually.

Caution should be exercised during this test since high-voltage testing is potentially hazardous.

Failure to perform the vacuum interrupter integrity test may cause serious injury or death.

High-potential test instruments can be purchased to perform the vacuum interrupter integrity test. The following is a recommended test instrument:

Hipotronics Model 7BT60A

Use of a DC Hipot is not recommended because results may indicate a problem with a good interrupter. If you wish to use a DC Hipot, test at 28kV. If the interrupter fails, confirm failed interrupter using above AC Hipot.

Note: Before performing vacuum integrity test, confirm that both the armature gap setting and contact wear adjustment are proper.

1. With the contactor in the open position connect the test leads to the contactor power terminals as shown in Figure 21. Apply 20kV rms, 60-Hertz power for 400 ampere and 800 ampere contactors and hold for a minimum of five seconds.
2. Reverse the leads and repeat the test.
3. If no breakdown occurs the interrupter is in an acceptable condition. If a breakdown occurs, the interrupter should be replaced. Refer to the "Interrupter Replacement" section for the contactor.

Note: No attempt should be made to try to compare the condition of one vacuum interrupter with another nor to correlate the condition of any interrupter to low values of DC leakage current. There is no significant correlation.

4. After the HIGH POTENTIAL VOLTAGE is removed from the interrupters the metal end caps of the interrupters should be discharged with a grounding rod to remove any residual electrical charge.

Figure 21. Testing the vacuum interrupter.
Section 12 – Latch Mechanism

General

The mechanical latch mechanisms that are used on Vacuum Limitamp Contactors are mounted directly to the contactors.

The purpose of the latch is to hold the contactor closed without the need for continuous coil power. The contactor can be closed (latched) by energizing the main contactor closing coil. Once the contactor is latched the power to the main closing coil should be removed to prevent coil overheating. To open (unlatch) the contactor, power is applied to the unlatch coil on the latch mechanism. Once the contactor is open the power to the unlatch coil should be removed to prevent coil overheating.

The latch mechanism can also be unlatched manually by operating the manual release mechanism if a contactor with the “L2” latch option is specified.

Adjustment Procedure

1. Steps 2 through 4 describe the steps necessary to mount the latch mechanism to the contactor. If the latch mechanism is already assembled on the contactor, proceed directly to Step 5 for adjustment procedure for the latch.

2. Mount the latch mechanism to the contactor using the two (2) latch-mounting screws supplied. The latch mounts directly to the center mounting post of the contactor coil. The latch-mounting plate is provided with a clearance hole for the center-mounting screw on the contactor coil.

3. Assemble the catch (see Figure 22) to the contactor moving armature using one each 0.010”, 0.030” and 0.060” shims and the hardware provided.

4. Connect the control wires to the unlatch coil terminal block on the side of the latch mechanism support bracket (see Figure 22).

5. Close the contactor electrically and allow to latch closed. Note that both the main closing coil and the unlatch coil have to be deenergized after operation to prevent coil overheating. With main coil deenergized, measure gap between centerline of contactor moving armature and the main coil pole faces. Desired range for this separation between pole faces is 0.009” to 0.013”. If outside this range, manually unlatch contactor, then add or remove shims as required to meet desired range (see Figure 22) and repeat measurement.

6. With contactor still latched closed, energize main coil. Set nut and release knob (see Figure 22) so that dimension “X” is equal to 0.060” +/- 0.005”. Deenergize main coil.

7. Manually operate the latch by pulling the release knob. The latch mechanism should move freely and the contactor should move to the fully open position.

8. Electrically operate the latch and unlatch coils to insure that these operate properly.

9. When the latch is properly adjusted the “RESET” end of the contact wear gage must be able to be inserted into the gap at the top of the vacuum interrupter driver stem on all three phases.

Figure 22. Cross-sectional view of latch mechanism.
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