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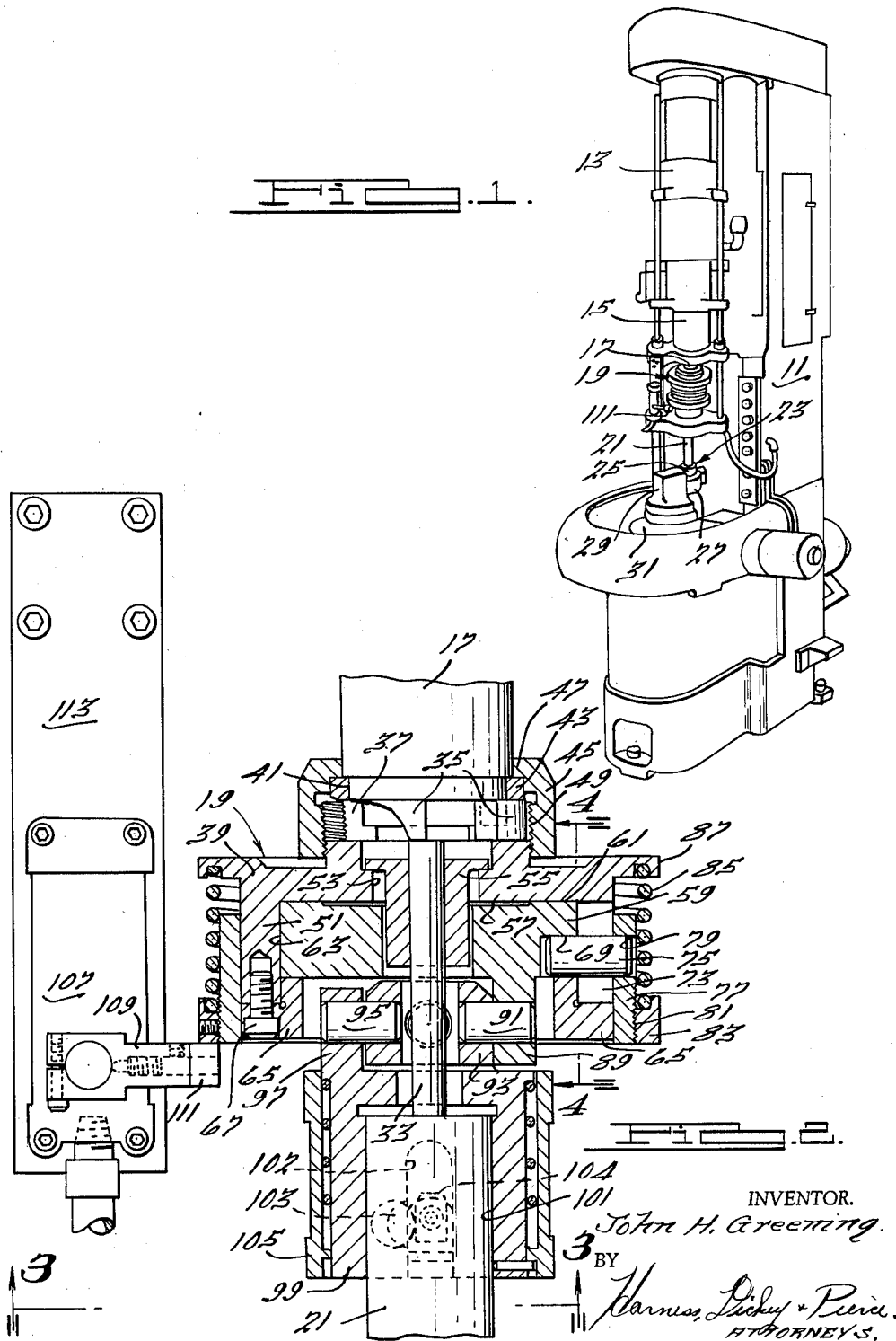
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TORQUE ACTUATED CONTROL DEVICE FOR HONING TOOLS

Filed Oct. 6, 1958

2 Sheets-Sheet 1



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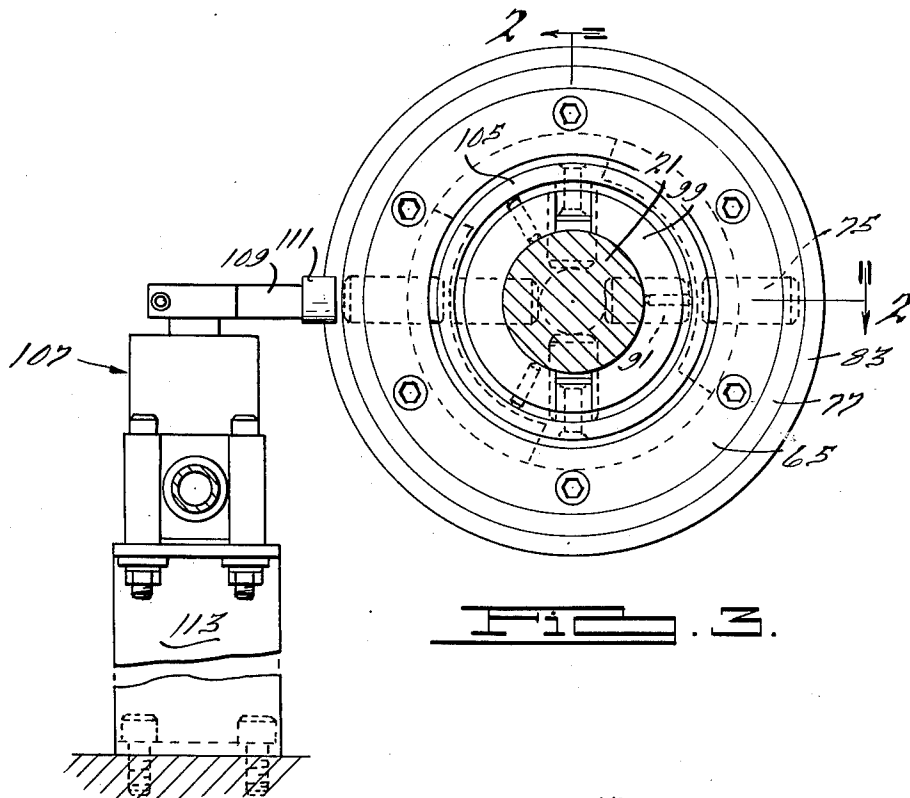


FIG. 3.

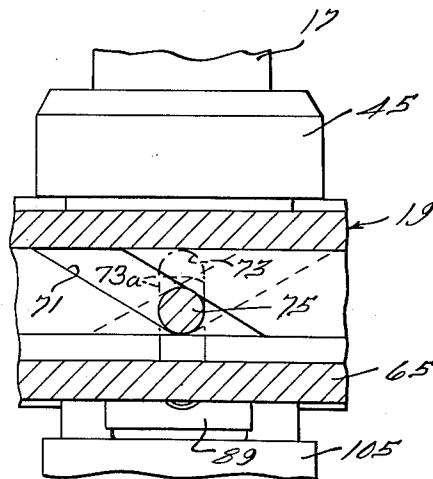


FIG. 4.

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TORQUE ACTUATED CONTROL DEVICE FOR HONING TOOLS

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This invention relates to honing machines and particularly to a control device actuated by changes in the driving torque.

The usual honing tool for the honing of cylindrical bores carries a plurality of abrasive stones about the periphery of its work head which are radially expandable and contractible in and out of engagement with the bore wall. The honing tool also includes an elongated drive shaft which is connected to the drive spindle of a honing machine and by means thereof the tool is driven in reciprocation and rotation within the bore of a workpiece. Disposed within the drive shaft of the tool is an actuating rod which engages end cam elements within the work head of the tool at one end thereof and interengages at its other end with a similar actuating rod within the spindle of the honing machine. As reciprocatory and rotational movement is transmitted to the abrasive stones through the machine spindle and tool drive shaft, the actuating rods within may be fed axially with respect to the spindle and drive shaft in order to radially advance or retract honing stones.

When a honing tool is initially introduced into a workpiece bore the honing stones are maintained in a contracted position out of engagement with the wall of the bore. The actuating rod is then fed axially downward in order to radially expand the honing stones into engagement with the bore wall. Thereafter, the honing stones are slowly expanded during the honing operation in order to compensate for the material abraded away from the stones and also to continually increase the diameter of the bore being honed. In order to conduct the honing operation in an efficient manner and to avoid wasted time, it is desirable that the initial feed of the actuating rod be such as to rapidly advance the stones into engagement with the bore wall. However, upon engagement of the stones with the bore wall the feed of the actuating rod, and hence the expansion of the stones, must be reduced to a smaller predetermined rate. If the stones were driven too rapidly after their initial contact with the bore wall, the stones would tend to crack under an ever-increasing frictional load and injury to the bore wall could also result.

Even after the engagement of the stones with the bore wall it is frequently desirable to alter either the rate at which the stones are expanded or the rotational speed of the machine spindle. The first metal which is honed from a bore is generally amorphous metal left on the wall of the bore by the previous machining operation. This metal is rather easy to remove and a high spindle speed and comparatively rapid stone feed rate may be used. However, when the surface metal has been removed and the stones are abrading against solid base metal, higher frictional resistance is encountered and either the spindle speed or feed rate, or both, should be reduced. Both upon the initial engagement of the honing stones with the bore wall and also upon the transition from amorphous surface metal to solid base metal, the increased resistance of the tool work head to rotation produces an increment in the driving torque. Accordingly, it is an object of the present invention to provide a device operable to sense changes in torque in the driving mechanism in order to control certain aspects of the honing operation.

It is an additional object of the present invention to provide a device by means of which the abrasive stones of a

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honing tool may be rapidly expanded into contact with the bore wall and thereafter expanded at a reduced rate of speed.

It is a further object of the present invention to provide a device by means of which the honing stones of the honing tool may be rapidly contracted upon completion of the honing operation after the honing stones have been moved out of abrading contact with the bore wall, thereby expediting removal of the honing tool from the bore.

It is another object of the present invention to provide a device operable to effect changes in spindle speed or stone feed rate in response to the higher drive torque produced by the honing stones moving through amorphous surface metal into more solid base metal.

It is still another object of the present invention to provide a torque sensing device which may be used as a safety overload device to terminate or reduce the rate of the honing operation in response to excessive frictional loading of the honing tool by too rapid advancement of the stones.

It is still another object of the present invention to provide a device of the above character which may be incorporated in an adapter for coupling the drive shaft of the honing tool to the machine spindle and which permits removal and installation of the tool in a convenient manner without disturbing the adapter device.

It is still another object of the present invention to provide a device of the above character which is sturdy in construction, reliable in operation and inexpensive of manufacture.

These and other objects of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a perspective view of a honing machine having the device of the present invention installed thereon;

FIG. 2 is a sectional view of the device of the present invention illustrated in FIG. 1 taken along the line 2—2 of FIG. 3;

FIG. 3 is a view of the structure illustrated in FIG. 2 taken along the line 3—3 thereof; and

FIG. 4 is a fragmentary sectional view of the structure illustrated in FIG. 2 taken along the line 4—4 thereof.

Referring now to the drawings, FIGURE 1 illustrates a typical honing machine on which the device of the present invention may be installed. The machine includes a frame 11 having a stationary head or housing 13 within which a piston or quill 15 is supported for vertical reciprocation. A drive spindle 17 is rotatably housed in the quill 15 and extends vertically downward therefrom. The device of the present invention is illustrated in the form of an adapter 19, secured to the lower end of the spindle 17, serving to drivably connect the drive shaft 21 of a honing tool 23 to the spindle 17. It should be understood, however, that the device of the present invention may be installed in other locations in the rotary drive mechanism connecting the honing elements to their source of rotary power.

As may be seen in FIG. 1, the honing tool includes a work head 25 shown positioned within a workpiece 27 held by a fixture 29 on a base 31 of the machine. Spaced around the periphery of the work head 25 of the honing tool are a plurality of abrasive honing stones (not shown) which are radially expandable and contractible. Positioned within the work head 25 are a plurality of cam elements (not shown) in abutting engagement with the honing stones and which are engageable by an actuating rod 33 (FIG. 2). As the honing tool is rotated and reciprocated within the workpiece, the actuating rod 33 may be axially fed within the tool drive shaft 21 in order to expand or contract the honing stones. The arrangement of the

honing stones in the work head, the construction of the cam elements and the other mechanism through which the stone may be expanded and contracted by an axially movable rod disposed within the tool are all well known in the art and form no part of the present invention. An example of structure of this nature is disclosed in my copending application entitled Honing Tool Having Full Floating Body, Serial No. 734,520, filed May 12, 1958, and assigned to the assignee of the present invention.

The details of the adapter unit 19, embodying the principles of the present invention, may be clearly seen in FIG. 2, wherein the lower end of the spindle 17 is shown as being provided with spaced keys 35 adapted to engage in keyways 37 formed in the upper end of a drive adapter or driving member 39. In addition, a groove 41 is formed around the periphery of the spindle 17 within which a split ring 43 is seated. An internally threaded collar 45 is provided with an inwardly turned flange portion 47 engaging the ring 43 and holding the spindle 17 in engagement with the drive adapter 39 by its threaded engagement with threads 49 formed around the upper end thereof. The drive adapter 39 has a lower annular wall 51, concentric with the axis of rotation of the device, and is also provided with a central axial bore 53 receiving a guide bushing 55 through which the actuating rod 33 extends. A flat annular shoulder 57 surrounds the bore 53 within the wall 51 and is slidably abutted by a cam member or driven member 59 having a flat upper surface 61 and a circular cylindrical outer surface 63 slidably fitted against the inner side of the annular wall 51. The cam member 59 is held in assembly with the drive adapter 39 by means of a retaining ring 65 abutting the underside of the cam member 59 and secured to the drive adapter 39 by screws 67. The retaining ring 65 serves to secure the cam member 59 within the annular wall 51 yet permits relative rotational movement between the cam member 59 and drive adapter 39.

The outer cylindrical surface 63 is provided with a pair of inclined grooves 69 formed on opposite sides thereof and having lower or cam surfaces 71. In addition, the annular wall 51 of the drive adapter is provided with a pair of axially extending slots 73 disposed radially opposite the cam grooves 69. The slots 73 are defined in part by a pair of opposite vertical and axially disposed walls or shoulders 73a. A pair of torque pins 75, disposed radially of the assembly, extend through the slots 73 and into the cam grooves 69 so as to be smoothly slidable therein. The torque pins 75 cooperate with the cam surfaces 71 to form cam means drivably interconnecting the driving member 39 and driven member 59. The cam surfaces 71 are disposed on a helix adjacent the periphery of the cylindrical wall 63 and coaxial with the axis of rotation so that upon axial displacement of the driving member 39 and driven member 59 a portion of the cam surfaces 71 will remain in juxtaposition to the slots 73. An annular axially movable supporting member 77 is fitted freely around the annular wall 51 and is provided with a pair of aligned apertures 79 in which the torque pins 75 are press fit. The lower outer surface of the member 77 is threaded at 81 for the reception of an adjustable collar 83 which forms the seat for a large coil spring 85 held in compression between the collar 83 and an annular outwardly extending lip 87 formed on the drive adapter 39. The spring 85 thus biases the member 77 downwardly, tending to maintain the torque pins 75 at the bottom of the cam grooves 69 and slots 73 and in engagement with the retaining ring 65.

A pair of apertured lugs 89 depend from the cam member 59 to receive a pair of opposite pivot pins 91 projecting radially outwardly from a gimbal ring 93 positioned therebetween. A second pair of pins 95 extend from opposite sides of the gimbal ring 93 perpendicularly to the pins 91 and are received in apertures formed in a pair of spaced lugs 97 extending upwardly from a retaining sleeve 99. The sleeve 99 is provided with a bore 101 adapted to

snugly receive the upper end of the honing tool drive shaft 21. The gimbal ring 93 thus affords limited relative universal movement to the retaining sleeve 99 and drive shaft 21 to compensate for minor misalignments between the spindle 17 and the bore of the workpiece 27. The sleeve 99 is provided with a bayonet type slot 102 into which a pin 103 carried by drive shaft 21 extends. A stop block 104 carried by a shroud 105 extends into the slot 102 and serves to lock the pin 103 in position, assuring positive driving connection between the drive shaft 21 and the sleeve 99.

Upon rotation of the honing tool with the honing stones out of engagement with the bore wall only a small degree of torque will be applied to the drive shaft 21. Under such circumstances the coil spring 85 exerts sufficient force to maintain the torque pins 75 at the bottom of the cam surfaces 71. However, when the honing stones are advanced into engagement with the bore wall, frictional resistance to rotary motion will be created and substantial torque will be developed in the drive mechanism. This torque is transmitted from the wall of the slot 73 through the torque pin 75 to the cam member 59. If the spring 85 is of a proper limited strength the driving torque of the torque pin 75 will be sufficient to cause it to ride up the cam surface 71 of the cam groove 69, while at the same time moving upwardly within the slot 73. Such movement is caused by an angular displacement between the drive adapter 39 and the cam member 59 which is, of course, responsive to the application of a predetermined driving torque. In this sense, the torque pins 75 may be termed as torque responsive members. By providing springs of varying strengths and also by adjusting the collar 83 to compress the spring 85 in varying amounts, the torque necessary to cause the upward movement of the torque pin 75 may be varied. It will also be appreciated that the angle of inclination of the cam surface 71 affects the propensity of the torque pin 75 to move therealong. In the embodiment illustrated herein the cam surface 71 is disposed on an angle of 30 degrees to a plane perpendicular to the axis of rotation. This angle has been found satisfactory for the purposes illustrated herein but, of course, cam surfaces of other angles could be utilized.

In order to sense the movement of the torque pin 75 and the axial movement of the torque pin supporting member 77, signal means in the form of a switch 107 is provided having a spring-biased sensing arm 109 carrying a roller 111 engageable with the underside of the collar 83 so as to roll therealong during the honing operation. The sensing arm is mounted on a bracket 113 which is secured to the quill or piston 17 so as to reciprocate therewith. By upward axial movement of the member 77, and thus the collar 83, the arm 109 pivots upwardly under the bias of its spring (not shown) in order to make or break the contacts of the switch 107. The switch 107 may be wired to the control panel of the honing machine in order to actuate the motors controlling the feed of the honing stones and/or the rotational speed of the spindle 17. Thus, if it were desired to reduce the stone feed rate upon contact of the stones with the bore wall, the switch 107 would be wired to the driving motors for the actuating rod 33 and upward pivotal movement of the arm 107 in response to an increased torque created by the contact of the honing stones with the bore wall would cause a reduction in the rate of feed of the actuating rod 33. Upon disengagement of the honing stones from the bore wall and relief of the high torque, the spring 85 will operate to move the member 77 and collar 83 downwardly, thereby pivoting the arm 109 downwardly and operating the switch 107 to cause a rapid retraction of the honing stones. It will be noted that if the member 73 fails to return to the lower position, the device is fail safe, for it will never go into rapid feed and possible damage to the work is avoided.

It will be apparent that by the provision of a spring of a suitable predetermined strength the device of the

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present invention may be used for sensing any substantial change in torque. Thus, by providing a stronger spring 85 the device may be used to switch from a rapid feed to a slow feed when the honing stones have finished honing through the relatively easily removed surface metal and have reached the more solid high resistance base metal of the bore. In addition, it would be possible to use the device merely as an overload safety control by providing a spring 85 of such strength that the pins 75 would not move up unless a torque were developed which was in excess of any desired amount and indicated that the stones were binding.

While it will be apparent that the preferred embodiment herein demonstrated is well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. In a honing machine operable to rotate and reciprocate a radially expansible honing tool, a control device including a driving member operable to transmit rotary power to the honing tool, said driving member having an annular wall coaxial with the axis of rotation and provided with an axially extending slot therein, a driven member supported for rotation relative to said driving member and having a helically disposed cam surface in juxtaposition to said slot, a pin slidably disposed in said slot and slidably engaged with said cam surface, said pin forming a driving connection between said members, spring means opposing movement of said pin in said slot, said members being angularly displaceable by a torque sufficient to overcome said spring means whereby said pin is moved axially in said slot by movement of said cam surface over said pin, and signal means operable to detect movement of said pin and control the operation of the honing machine in response thereto.

2. In a honing machine operable to rotate and reciprocate a radially expansible honing tool, a device for transmitting rotary power to the honing tool including a driving member having an annular wall coaxial with the axis of rotation of the device and provided with an axially extending slot therein, a driven member supported for rotation relative to said driving member and having a cam surface disposed on a helix in juxtaposition to said slot, an annular supporting member concentric with the axis of rotation and surrounding said driving member, a pin secured to said supporting member and extending through said slot and into sliding engagement with said cam surface, spring means opposing movement of said pin in said slot, said driving and driven members being angularly displaceable by a driving torque sufficient to overcome said spring means whereby said pin is moved axially in said slot by relative movement of said cam surface and said driving member whereby said supporting member is moved axially; and switch means having a movable arm slidably engaging said supporting member as it rotates relative thereto, said arm being movable in response to axial movement of said supporting member to actuate said switch means.

3. A honing machine control device including mechanism through which rotary power is supplied to a ra-

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dially expansible and contractible honing tool, said mechanism having a driving member and a driven member, one of said members being annularly disposed about the other of said members, a helical cam surface on one of said members and a generally axial shoulder on the other of said members, a torque member interconnecting said driving and driven members and engageable with said helical cam surface and said axial shoulder whereby said torque member will be moved axially upon relative angular movement of said members, means yieldingly opposing axial movement of said torque member to restrain relative angular movement of said driving and driven members; and means operable to sense movement of said torque member for controlling the operation of the honing machine.

4. The structure set forth in claim 3 in which said driving member is disposed about said driven member and said honing tool is provided with a drive shaft connected to said driven member radially inwardly of said driving member.

5. The structure set forth in claim 3 in which said driving member is provided with diametrically opposite lug portions, said honing tool is provided with a driven shaft having diametrically opposite lug portions offset 90° with respect to the lug portions on said driven member, and a gimbal ring is pivotally connected to said lug portions providing universal movement between said driven member and said honing tool.

6. The structure set forth in claim 3 in which an annular member is connected to said torque member for axial movement therewith and said means operable to sense movement of said torque member includes a switch mechanism having an actuating arm biased by said annular member and adapted to be actuated upon axial movement of said annular member.

7. A honing machine control device including mechanism through which rotary power is supplied to a radially expansible and contractible honing tool, said mechanism having a driving member and a driven member, one of said members being annularly disposed about the other of said members, one of said members having a helical slot provided with a cam surface and the other of said members having a generally axial slot provided with an axial shoulder, a torque transmitting element interconnecting said driving and driven members and engageable in said helical slot and said axial slot whereby said torque member will be moved axially upon relative angular movement of said members, means yieldingly opposing axial movement of said torque transmitting element to restrain relative angular movement of said driving and driven members; and means operable to sense movement of said torque transmitting element for controlling the operation of the honing machine.

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