ELECTRO-MAGNETIC CLAMP FOR GRIPPING A SHAFT

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ABSTRACT

A clamp for locking engagement with a shaft includes a body having a bore for slidably receiving a shaft, with opposing grippers recessed into the body coaxial with the shaft. The grippers each include inner and outer sleeves displaceable relative to each other, with the outer sleeves being retained by shoulders within the body and the inner sleeves being slideable within a pocket for selectively releasing and gripping the shaft. A pair of opposing plungers selectively displaces the inner sleeves, the plungers each being associated with a slideable arm for coordinated gripping and release of the shaft. The arms are drawn together or apart by an actuator such as a solenoid. The clamp is intended to be fastened to a component, for permitting the component to selectively grip a shaft, or release the shaft for slideable and/or rotatable movement relative to the shaft, such as an optical instrument for testing of patient’s eyes which when fastened must tightly grip a shaft to prevent rotation and slideable movement, but which when released must permit free movement relative to the shaft.
ELECTRO-MAGNETIC CLAMP FOR GRIPPING A SHAFT

FIELD OF THE INVENTION

[0001] The invention relates to a releasable clamp for gripping a shaft, for holding a component in a selected fixed position relative to a shaft.

BACKGROUND OF THE INVENTION

[0002] Mechanical and electro-mechanical devices for holding a component in position in relation to a shaft have applications in many fields. For example, an optical device for measuring a patient’s eyes must be precisely positioned in relation to the patient, requiring that the device be freely moveable along a shaft until it reaches the correct position, at which time it must be clamped to the shaft in a releasable fashion but which holds it firmly in place. Numerous other applications exist for a clamp which releasably holds a component in a fixed position along a shaft, but which may be readily released to permit either sliding or rotary movement or both. Existing clamps may comprise a clamp body which supports a pair of angled plates having an aperture therethrough, the plates being pivotable about one end such that a shaft passing through the plates may slide or rotate freely therethrough when the plates are steeply angled relative to the shaft, but is prevented from moving when the plates are more shallowly angled. However, this type of system is subject to a high level of wear and other drawbacks. Other systems have been proposed, all of which involve a relatively high degree of complexity. There is a need for a relatively simple, effective clamp suitable for actuation by electromagnetic means such as a solenoid motor.

[0003] A variety of mechanical clamping systems have been proposed for releasably fixing a component to a shaft in a manner such that the component may be readily re-positioned on the shaft. For example, U.S. Pat. No. 5,052,842 to Junata discloses a slotted hub having a central bore for receiving a shaft, with a screw to tighten the collar around the shaft for locking engagement. In a somewhat similar fashion, U.S. Pat. No. 4,142,811 to Burnham discloses a hub having a central bore, with the hub being perforated with threaded openings to receive a plurality of screws which when tightened directly or indirectly contact a shaft extending through the bore. Upon tightening the screws, contact is made with the shaft thereby locking the shaft relative to the hub.

[0004] Another type of locking system is disclosed in U.S. Pat. No. 4,893,819, the commercial embodiment of which is the “Grip Fast”® collar, and is specifically intended for locking athletic weights to a barbell shaft. The collar comprises concentric inner and outer sleeves, the inner sleeve having a plurality of openings to receive bearings extending partway through the openings. A plurality of wedges is positioned to contact the bearings, such that when the outer sleeve is aligned relative to the inner sleeve, the bearings are wedged inwardly and extend through the inner sleeve so as to contact and lock the shaft in position. Axial displacement of the sleeves relative to each other permits the bearings to retract, thereby releasing the shaft. The inner and outer shafts are spring biased relative to each other so as to maintain the locked position until the user retracts the outer sleeve. Similar locking systems are disclosed in U.S. Pat. Nos. 4,395,051 and 4,453,449.

SUMMARY OF THE INVENTION

[0005] An object of the invention is to provide an improved clamp for releasably fastening a component along a shaft, such that when released the component may be rotated or slid along the shaft, or both rotated and slideably displaced, and which when engaged, prevents either axial or rotary movement, or both, relative to the shaft. A further embodiment is to provide such a clamp which may be actuated by an electromagnetic component such as a solenoid.

[0006] In one aspect, the invention relates to a clamp for gripping an elongate shaft comprising a clamp body having a bore for slidably receiving the shaft. Within the body is provided at least two opposing shaft grippers coaxial with the bore for selectively gripping the shaft. The shaft grippers are of the type comprising a pair of concentric sleeves displaceable relative to each other, whereby when aligned the outer sleeve urges bearings or other contact members to press against the shaft so as to firmly grip the shaft to prevent movement relative to the gripper, and when displaced the contact members retract to release the shaft. Alternatively, the gripping may occur when the sleeves are displaced relative to each other and release when aligned. Typically, such grippers are most effective only in a single direction, since a retraction of the shaft in a first direction cooperates with the wedging action of the contact members, while retraction in an opposed direction will release the gripper. Thus, in order to prevent shaft slippage in either axial direction, it is desirable to provide a pair of grippers within the clamp body, aligned along the shaft and in opposing directions whereby they may be simultaneously actuated for gripping or releasing the shaft.

[0007] In order to actuate the grippers, a pair of opposing plungers is provided for contacting the inner sleeve of each gripper so as to urge the inner sleeve inwardly towards the center of the body, so as to release the shaft. The grippers are recessed into the clamp body. The outer sleeve of each gripper is fixed in position, by abutting against a shoulder within the interior of the clamp body. The inner sleeve can move axially within a pocket inboard of the shoulder. The plungers are each operatively connected to an arm extending outwardly from the body, the arm mounted to the body for sliding movement in a direction axial to the shaft. For example, the arm may be engaged to the body by means of one or more guide pins. Conveniently, the arms include an opening to permit the shaft to pass through the arm, such that the arms may be positioned on either end of the body in a generally central position. Drawing the arms towards each other will thus urge the plungers inwardly towards each other, thereby releasing the shaft so as to slide and rotate freely within the clamp body, while urging the arms apart from each other has the opposite effect. It will be readily seen that the invention may work equally well in the reverse direction, whereby the grippers operate in the reverse direction and urging the arms apart would serve to grip the shaft to the clamp body.

[0008] The grippers may be biased so as to urge the arms apart so as to firmly engage the shaft unless the arms are urged together by a user to release the shaft. A solenoid
motor or other linear actuator may join the respective arms, the motor being actuated by a controller so as to rapidly release or engage the grippers by urging the arms together or apart.

[0009] The body is conveniently provided with bosses or other fasteners to permit the attachment of components. The bosses may permit the rotatable attachment of components to the clamp body.

[0010] The present invention will now be further described by way of a detailed description of a preferred embodiment. It will be understood that this description merely illustrates an example of the invention and is not intended to limit the scope of the invention in any respect. Rather, a full scope of the invention is described in this specification as a whole, including the claims. It will be understood that unless otherwise specified, any element or component described herein may be replaced by an obvious mechanical equivalent. Further, directional or geometric references herein are not intended to be read in a strictly limiting sense, for example a reference to a “cylindrical shaft” may include a shaft having a non-circular cross-section. In similar fashion, directional references herein are generally provided merely for convenience of description. It will be understood that the invention may be readily used in any orientation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a side elevational view of the clamp, partly in section to illustrate the internal components.

[0012] FIG. 2 is a side elevational view of the clamp body, showing internal elements in dotted lines.

[0013] FIG. 3 is a front elevational view of the clamp.

[0014] FIG. 4 is a perspective view of the clamp body.

[0015] FIG. 5 is a perspective view of the clamp body engaged to a shaft and mounted to an optical component.

[0016] FIG. 6 is a sectional view of an example of a prior art gripper for use in the present invention.

DETAILED DESCRIPTION

[0017] Referring to the Figures, the clamp body 10 comprises a suitable rigid material, such as a metal such as stainless steel or aluminum, or injection-molded plastic. The body includes a central bore 12 for receiving the shaft 14 in a manner which permits the shaft to slide and rotate freely within the bore when the clamp is in the released position. The bore is symmetrical about its elongate axis, with widened cylindrical recesses 16 at each of its opposed, outward ends to receive a pair of opposed grippers 24, described below. The recesses 16 open to the opposed ends 18 of the body. The base of each recess 16 is inwardly stepped and comprises an annular shoulder 20 for abutting the outer sleeve 22 of a gripper 24, and a recessed pocket 26 to receive the inner sleeve 28 of gripper 24 to permit a degree of axial movement of the inner sleeve 28 relative to the outer sleeve 22 which is fixed in position. Protruding outwardly from opposing positions on either side of the body is a pair of bosses 30, for mounting a component to the body (not shown). The mountable component may comprise any suitable item or component which includes mating members for attachment to the bosses. It is contemplated that a useful application for the clamp is to fasten an optical instrument for use by optometrists to measure a patient's eyes. However, this is but one example of a suitable application. As will be seen in FIG. 5, the bosses may be provided with a lock 32 to fasten the component 33 to the bosses, and a pivot mount 34 to permit pivoting of the component. The component 33 is shown here as comprising an element of an optical system for measuring patient eyes. It will be readily seen that this is but one example of the many possible applications of the clamp.

[0018] The shaft 14 extending through the central bore 12 is of any suitable material in cross-sectional configuration. It is contemplated that the shaft 14 is cylindrical, but it will be seen that the system may be adapted for use with shafts having other cross-sectional shapes.

[0019] Inserted within each recess is a gripper 24, the preferred type being a somewhat modified version of the gripper sold under the trade-mark "GripFast™". As seen in detail in FIG. 6, the gripper 24 comprises concentric inner and outer sleeves 28 and 22. The inner sleeve 28 includes a plurality of openings 29 to each receive a bearing 31 capable of extending partway through the openings 29. The outer sleeve 22 is associated with a wedge-shaped member 35 in contact with the bearings 31 such that when the sleeves are aligned the member 31 urges the bearings 31 partway through the openings 29, so as to tightly contact the shaft 14 to prevent axial movement of the shaft. A spring 37 or other biasing means urges the sleeves towards their aligned, gripping position.

[0020] The shaft diameter must be selected so as to match the appropriate shaft size for the gripper 24. In its normal rest position wherein the inner and outer sleeves 28, 22 are aligned, the bearings are urged inwardly against the shaft 14 so as to lock the shaft, by means of an array of wedges which contact the bearings. Displacement of the inner sleeves 28 towards each other, namely inwardly towards the mid-line of the body, causes the bearings to retract thereby releasing the shaft 14 for free rotational and axial movement. Within the body 10, the outer sleeve 22 contacts the shoulder 20 to prevent movement as the inner sleeve 28 is urged towards the mid-line of the body 10. The inner sleeve 28 is permitted a degree of free travel, within the pocket 26. The pocket 26 terminates at its base in a shoulder 40 for contacting the inner sleeve 28 at a suitable point to prevent excess movement. The grippers 24 are spring biased so as to return their normal, locked position unless urged into their displaced, unlocked position by means to be described below.

[0021] The grippers selected in this embodiment permit the shaft 14 to rotate when locked. However it will be seen that a different choice of gripper would prevent rotation of the shaft when locked.

[0022] The outer surface of each gripper 24 is covered by an annular disc 44 which retains the gripper in position within the recess 16. The disc 44 is retained by a snap ring 46, which fits within an annular groove 48 within the recess 16.

[0023] The inner sleeves 28 of each gripper 24 may be displaced so as to release the shaft by means of a push collar 50, consisting of a tubular member 52 axially aligned with the grippers 24, the central bore 54 of which receives the shaft 14. The collar 50 has an outside diameter slightly
smaller than the inner sleeve 28 diameter, such that urging of the collar 50 against the inner sleeve 28 serves to displace the inner sleeve 28 inwardly towards the mid-line of the body 10 so as to release the shaft 14. A flange 56 at the outer rim of the collar 50 has a flat outside surface 58 to provide a relatively contact area for the actuator arms 60, discussed below. The collars 50 each slide freely along the shaft, and are retained in position by contact with the actuator arms 60. A pair of actuator arms 60 is provided to urge the collars 50 inwardly towards the mid-line of the body 10 so as to release the grippers 24. Each actuator arm 60 comprises a plate-like limb 62(a) arranged parallel to a respective end of the body 10 and spaced apart therefrom, for contact with a corresponding collar 50. A first of the arms 60(a) is generally L-shaped, with a second limb 62(b) at right angles to the first, for support a solenoid driver 64, discussed below. The second arm 60(b) is generally T-shaped, having an extended first portion 70 for supporting a solenoid plunger 75 opposed to the solenoid motor 66, and a second portion 72 for attachment to the body 10. The arms 60 are both mounted to the body 10 for vertical sliding movement along the axis of the shaft 14, for moving the collar 50 and inner sleeve 28 of the gripper 24 within a vertical direction (all direction references being relative to the shaft 14 being vertical). Mounting is effected by mounting the first part of each arm 60 to one or more guide pins 71 which protrude outwardly from the body 10. Each guide pin 71 fits within a corresponding recess 72 and is fixedly mounted within the recess. The actuator arms slide freely on the pins, through openings 74 extending through the corresponding arms. A stopper 76 at the end of each pin 71 limits travel of the arms 60 along the pins 71. The guide pins 71 are preferably fabricated from stainless steel and are provided with a mirror-like finish so as to provide smooth travel of the arms 60.

[0024] Vertical travel of the arms 60 is effected by a solenoid 64 mounted to the second, vertical limb of the first arm 60(a). The solenoid in this case is a Guardian™ 102 oz. It will be readily seen that the particular selection of solenoid or other linear actuator will depend on the desired application of the clamp and other obvious design constraints.

[0025] The solenoid motor 66 includes a plunger 75 extending vertically downwardly. The plunger 75 is pivotally mounted to an elongate pivot block 76, with the pivotal movement between the plunger 75 and pivot block 76 compensating for any misalignment of the moving components. The pivot block 76 in turn has a screw-threaded aperture 78 at its lower end, to receive a mounting screw 80 extending upwardly from the second actuator arm 60(b) so as to rigidly mount the pivot block 76 to the second arm 60(b). The adhesive screw 80 permits vertical height adjustment of the pivot block 76 so as to permit adjustment of the vertical travel of the respective actuator arms 60. The typical vertical travel of the arms 60 is about 0.076 inches for the first arm 60(a) and about 0.088 inches for the opposing arm 60(b).

[0026] In operation, the solenoid 66 may be actuated to release the shaft 14. In the normal, rest position, the solenoid 66 is retracted thereby maintaining the shaft 14 in the gripped, non-moving position relative to the clamp body 10. When actuated by a control system or directly by a user, the solenoid 66 retracts, thereby urging the opposed arms 60(a) and (b) towards each other and in consequence displacing the inner collar of each gripper towards an inboard direction relative to the outer collar. When sufficiently displaced, the shaft is released for free rotation and axial movement.

[0027] It will be seen that a modification of the invention provides a device wherein a release of the clamp permits only rotary or only axial movement of the shaft 14 relative to the clamp body 10. For example, the shaft 14 may be provided with an anti-rotatory member such as a rib or a flat in operative communication with a corresponding receiving member such as a slot or a corresponding flat within the grippers 24, thereby permitting axial movement but preventing rotation. In a corresponding fashion, the shaft 14 and clamp bore 12 may be provided with mating annular flanges and grooves, permitting rotary movement of the shaft when released but preventing axial sliding motion.

[0028] It will be further seen that the solenoid 66 may be controlled by any suitable control system, including a simple user-operable switch, or a central processing unit associated with other componentry. It will also be seen that any convenient linear actuator may be used in the position of the solenoid 66.

[0029] It will be seen that although a detailed description of individual embodiments has been presented, the present invention is not limited to any feature, element or principle of operation described in particular detail. Rather, the full scope of the invention is presented in this patent specification as a whole, including the claims and further including any structural or functional elements equivalent to those presented herein.

1. A clamp for releasable locking engagement with a shaft, comprising a clamp body having a bore extending therethrough to slidingly receive a shaft to permit the clamp and body to slide along said shaft when released, a pair of opposing shaft grippers coaxial with said bore for selectively gripping said shaft when actuated, each said gripper comprising inner and outer sleeves slideable axially relative to each other, wherein axial displacement releases or engages said shaft, said grippers being in opposing relation to each other wherein gripping and releasing of said shaft is effected by a coordinated displacement of said inner sleeves towards or away from each other, a pair of opposing plungers slideably engaged to said body for displacing said inner sleeves inwardly towards or away from the mid-line of said body, and a pair of opposing arms in effective contact with said plungers and slideably engaged to said body, for effecting coordinated displacement of said plungers, each said arm associated with an actuator for a coordinated diverging or converging of said arms so as to grip or release said grippers to said shaft.

2. A clamp as defined in claim 1, wherein said actuator comprises a solenoid having a solenoid body engaged to a first of said arms, and a solenoid plunger operatively engaged to the second of said arms wherein extension of said plunger diverges said arms and contraction of said plunger converges said arms.

3. A clamp as defined in claim 2, further comprising a pivot block pivotally mounted to said solenoid plunger between said first and second arms for absorbing misalignment therebetween.

4. A clamp as defined in claim 1, wherein said grippers are arranged for release of said shaft when said inner sleeves are each displaced in an inboard direction.

5. A clamp as defined in claim 3, wherein said grippers are arranged for release of said shaft when said outer sleeves are each displaced in an inboard direction.
5. A clamp as defined in claim 4, wherein said inner sleeves are biased to return to an outboard position when said plungers are retracted.

6. A clamp as defined in claim 1, wherein each of said grippers is retained within said body within a recess open to a corresponding end of said body, each said recess coaxial with said bore.

7. A clamp as defined in claim 1, further comprising at least two guide pins protruding outwardly in opposed directions for engaging said arms slideably to said body.

8. A clamp as defined in claim 1, wherein said grippers each comprise a plurality of openings in said inner sleeves; a plurality of shaft contact members extending partway through said openings for selectively contacting and gripping said shaft when urged partway through said openings, and at least one wedge associated with said outer sleeve for urging said members through said openings when said outer and inner sleeves are displaced relative to each other.

9. A clamp as defined in claim 1 wherein said grippers permit rotational but not axial movement of said shaft when engaged.

10. A clamp as defined in claim 1 wherein said grippers permit axial but not rotational movement of said shaft when engaged.

11. A clamp as defined in claim 1 wherein said grippers permit neither axial nor rotational movement of said shaft when engaged.