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(54) Title: OPTICAL PROBE WITH CRASH PROTECTION AND PROBE CLIPS

(57) Abstract: A probe head of a coordinate measuring machine ("CMM") includes a sensor to detect impact of the probe head with a foreign object. The probe head is movably coupled to the CMM such that the sensor detects motion of the probe head relative to a portion of the CMM resulting from an impact event. Some embodiments cause the CMM to take action in response to detecting an impact. Probe clips allow adjustment of the position of a CMM probe relative to the portion of the CMM from which the probe is suspended. This allows the position and orientation of the CMM probe to be adapted to a variety of applications.

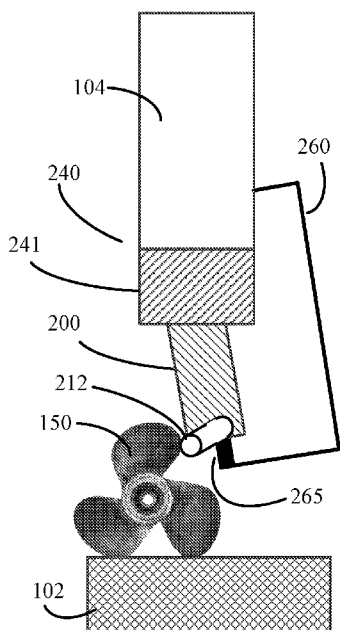


Fig. 2B



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- *with amended claims and statement (Art. 19(1))*

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## AMENDED CLAIMS

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What is claimed is:

1. A probe head for a coordinate measuring machine, the probe head comprising:
  - a mount;
  - a probe platform configured to support at least one optical probe, the probe platform movably suspended from the mount; and
  - a sensor operably coupled between the mount and the probe platform such that displacement of the probe platform relative to the mount is transmitted to the sensor,the mount, the sensor, and the probe platform configured so that contact between: A) the probe platform or one or more of the at least one optical probes coupled to the probe platform, and B) an object causes a change in an electrical property of the sensor.
2. The probe head of claim 1, wherein the sensor comprises a kinematic seat having electrically connectable conductive portions, the change in the electrical property including a break in a prior electrical connection between two of the electrically connectable conductive portions of the kinematic seat.
3. The probe head of claim 1, further comprising a stem between the probe platform and the sensor, the stem coupling the probe platform to the sensor and spacing the probe platform from the sensor.
4. The probe head of claim 1 further comprising a housing movably suspended from the mount and at least partially surrounding the probe platform, or a probe suspended from the probe platform.

5. The probe head of claim 4, wherein the housing is coupled to the probe platform via a rod, the rod configured to transmit mechanical force or motion from the housing to the sensor via the probe platform.
6. The probe head of claim 5 wherein the rod is thermally isolated from the housing via a hysteretic coupling, the hysteretic coupling configured to mitigate transmission, from the housing to the sensor, of mechanical motion in the housing resulting from thermal stress.
7. The probe head of claim 6 wherein the hysteretic coupling comprises an aperture in the housing, and a fastener passing through the aperture and securing the housing to the rod, wherein a diameter of the aperture is greater than a diameter of the fastener such that the fastener may pass through the aperture without touching an inner surface of the aperture.
8. The probe head of claim 4, wherein the housing comprises a mechanical interface to allow an optical cable to pass through the housing to reach an optical probe suspended from the boom.
9. The probe head of claim 4, wherein the housing has a weight and is movably suspended from the mount by a spring, wherein the spring is configured to hold the housing in a nominal position, relative to the mount, in the absence of displacement of the housing by contact between the housing and the object.
10. The probe head of claim 9, wherein the spring is configured to return the housing to the nominal position, relative to the mount, after removal of contact between the housing and the object.

11. The probe head of claim 4, wherein the housing comprises a rigid plate and a rigid apron, the plate coupled to the mount, and the apron movably coupled to the plate.
12. The probe head of claim 4, wherein the housing comprises a rigid plate and a rigid apron, the plate coupled to the mount, and the apron removably coupled to the plate.
13. A coordinate measuring machine for measuring a workpiece, the coordinate measuring machine comprising a base configured to support the workpiece during measurement, and an arm movable relative to the base, the arm configured to support at least one optical probe for measuring the workpiece under control of a controller, the coordinate measuring machine comprising:
- a probe platform coupled to the arm and configured to support the at least one optical probe; and
  - a sensor operably coupled between the arm and the probe platform such that displacement of the probe platform relative to the arm is transmitted to the sensor, the arm, the sensor and the probe platform configured so that contact between A) the probe platform or one or more of the at least one optical probes coupled to the probe platform, and B) an object causes a change in an electrical property of the sensor,
  - the controller configured to move the arm in response to the change in the electrical property of the sensor to mitigate damage to the probe platform or the sensor.
14. The coordinate measuring machine of claim 13 further comprising a housing movably suspended from the arm and at least partially surrounding the probe platform, or a probe suspended from the probe platform.

15. The coordinate measuring machine of claim 14, wherein the housing is coupled to the probe platform via a rod, the rod configured to transmit mechanical force or motion from the housing to the sensor via the probe platform.

16. The coordinate measuring machine of claim 15 wherein the housing rod is coupled to the rod via a hysteretic coupling, the hysteretic coupling configured to mitigate transmission, from the housing to the sensor, of mechanical motion in the housing resulting from thermal stress.

17. The coordinate measuring machine of claim 14, wherein the housing is movably suspended from the arm by a spring, the spring configured to hold the housing in a nominal position, relative to the arm, in the absence of contact between the housing and the object.

18. The coordinate measuring machine of claim 14, wherein the housing is movably suspended from the arm in a nominal position, wherein a spring operably coupled to the mount is configured to return the housing to the nominal position after removal of contact between the housing and the object.

19. A probe head for a coordinate measuring machine, the probe head comprising:  
a mount;  
a probe support means for supporting at least one optical probe, the probe support means suspended from the mount; and  
sensor means, operably coupled between the mount and the probe support means, for sensing displacement of the probe support means relative to the mount, the mount, the sensor means, and the probe support means configured so that contact between: A) the probe support means or one or more of the at least one optical probes coupled to the probe support means, and B) an object causes a change in an electrical property of the sensor means.

20. The probe head of claim 19 further comprising a housing means for shielding the probe support means, movably suspended from the mount and at least partially surrounding the probe support means.

STATEMENT UNDER ARTICLE 19 (1)

Original claims 1, 13 and 19 have been amended to specify that that the “at least one probe” is “at least one optical probe,” as reflected in the attached listing of claims on replacement pages 31-35.