Innovation, Sciences et Développement économique Canada
Office de la Propriété Intellectuelle du Canada

Innovation, Science and Economic Development Canada
Canadian Intellectual Property Office

CA 3095809 A1 2021/04/22

(21) 3 095 809

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(22) Date de dépôt/Filing Date: 2020/10/09

(41) Mise à la disp. pub./Open to Public Insp.: 2021/04/22

(30) Priorité/Priority: 2019/10/22 (US62/924,419)

(51) Cl.Int./Int.Cl. *A47B 9/20* (2006.01), *A47B 13/00* (2006.01), *B25H 1/16* (2006.01), *G02B 21/00* (2006.01)

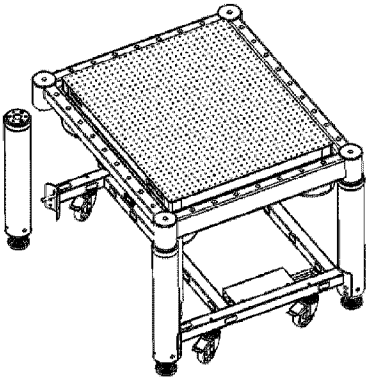
(71) Demandeur/Applicant:
THORLABS, INC., US

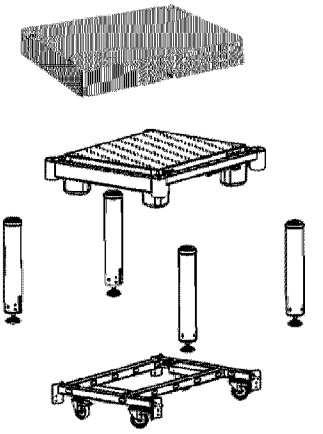
(72) Inventeurs/Inventors:
DHESE, KEITH, US;
GRIMWADE, DAVE, US;
SUBRAMANI, POOBALAN, US;
ARAUZ, LINA, US

(74) Agent: AGENCE DE BREVETS FOURNIER

(54) Titre : TABLE OPTIQUE MOTORISEE A HAUTEUR AJUSTABLE COMPRENANT UNE ISOLATION RIGIDE, PASSIVE ET ACTIVE

(54) Title: MOTORIZED, HEIGHT ADJUSTABLE OPTICAL TABLE WITH RIGID, PASSIVE AND ACTIVE ISOLATION





(57) Abrégé/Abstract:
Disclosed is a motorized, height adjustable optical table or workstation for use in microscopy, optical research laboratories and similar environments. The height adjustable design includes fixed and moving parts which combine to create a rigid, height adjustable table structure on which to mount an optical breadboard or similar platforms via rigid, passive or active vibration isolation mounts. The height adjustment is performed by multiple compact actuators with associated control hardware and software, and allows the user to perform duties in both the seating and standing positions, or any other positions.

ABSTRACT

Disclosed is a motorized, height adjustable optical table or workstation for use in microscopy, optical research laboratories and similar environments. The height adjustable design includes fixed and moving parts which combine to create a rigid, height adjustable table structure on which to mount an optical breadboard or similar platforms via rigid, passive or active vibration isolation mounts. The height adjustment is performed by multiple compact actuators with associated control hardware and software, and allows the user to perform duties in both the seating and standing positions, or any other positions.

Date Reçue/Date Received 2020-10-09

MOTORIZED, HEIGHT ADJUSTABLE OPTICAL TABLE WITH RIGID, PASSIVE AND ACTIVE ISOLATION

FIELD OF THE INVENTION

[0001] The present invention relates to laboratory desks, tables and workstations, and more specifically to motorized, height adjustable optical tables with rigid, passive and active isolation.

BACKGROUND

[0002] An optical table or workstation, such as the Thorlabs ScienceDesk, is commonly used for mounting microscopy equipment, optical equipment, accessories or similar equipment for use in optical laboratories or similar environments. Existing optical tables or workstations are of fixed heights. For example, the Thorlabs ScienceDesk is currently available in two fixed height versions. However, the varying nature of uses (equipment) and users (anthropometry) creates a wide range of height requirements for the table to which the equipment is mounted. For example, Fig. 1A shows a situation in which a user sits in front of a table and Fig. 1B shows another situation in which a user stands in front of a table. It is clear that the height requirements in Figs. 1A and 1B are different. Specifically related to microscopy, it has been observed that the shortest users often seek an additional stool or step to reach the microscope eyepiece as illustrated in Fig. 1C and the tallest users often bend their neck to reach the microscope eyepiece as shown in Fig. 1D. Fig. 1D also shows various medical problems associated with working with desks that are not at the appropriate height for the specific uses of the equipment.

[0003] Therefore, there is a long-felt need for a height adjustable optical table that is better able to cater for the varied height requirements of the uses of the equipment in any of the applications in which the optical table is used. A height adjustable optical table

Date Reçue/Date Received 2020-10-09

allows a user to raise or lower the table to standing, seating or any other position in between to achieve a comfortable working height during extended periods of use, thus improving the user ergonomics and reducing the likelihood of strain injuries.

[0004] Height adjustable tables with hydraulic, pneumatic and electrical actuator technology are available, but not in combination with optical tables. This is because an optical table is a vibration control platform that is used to support systems used for laser- and optics-related experiments, engineering and manufacturing. The surfaces of these optical tables are designed to be very rigid with minimum deflection so that the alignment of optical elements remains stable over time. Many optical systems require that vibration of optical elements be kept small. As a result, optical tables are typically very heavy and incorporate vibration isolation and damping features in their structure. Because of the above strict technical requirements, height adjustable optical tables or similar do not exist in the marketplace.

[0005] Handling, storage and shipping is another problem area that needs to be addressed. Current available optical tables are fully assembled, packed and stored as a complete package by the manufacturer. For example, as shown in Fig. 2, the Thorlabs ScienceDesk is fully assembled, packed and stored as a compete assembly by Thorlabs Ely (UK). The large assembly package is then shipped globally to the end user.

[0006] However, not all customers have a wide enough entrance to allow the fully assembled optical table into their desired location which can limit or even prevent sales. For example, Thorlabs would like to have the option to send the tables in a modular format to assist with handling, storage and shipping in addition to the option to send the tables to the customers fully assembled. Therefore, there is also another long-felt need for more compact optical table shipping packages to accommodate narrower entrances and other transportation requirements and limitations.

Date Reçue/Date Received 2020-10-09

SUMMARY

[0007] An embodiment of the present invention is a motorized, height adjustable optical table or workstation for use in microscopy, optical research laboratories and similar environments. The height adjustable design includes fixed and moving parts which are combined to create a rigid, height adjustable table structure on which to mount an optical breadboard or similar platforms via rigid, passive or active vibration isolation mounts. The height adjustment is performed by multiple compact actuators with associated control hardware and software, and allows the user to perform duties in both the seating and standing positions, or any other positions.

[0008] An embodiment of the present invention provides an optical table including: a base section; a top section; a plurality of legs assemblies, each leg assembly including a housing; a motorized actuator fitted in the housing configured to retract or extend with the motion being supported by a number of guide pillars and bearing assemblies; a sensor configured to sense the positions of the motorized actuator in the plurality of leg subassemblies; and a processor configured to control the actuators based on the sensed positions; wherein the plurality of legs assemblies are configured to have their housings mounted to the base section and to have their corresponding upper section mounted to the top section at their corresponding locations.

[0009] According to one embodiment, the motorized optical table structure has been converted from a fully welded assembly to a partially welded modular structure allowing compact packaging with easily configurable modules. This permits laboratories or similar environments with small entrances access to the largest size of motorized optical tables or workstations. The modular nature of the motorized optical table in accordance with an embodiment of the present invention is shown in Fig 3.

[0010] An embodiment of the present invention provides a shipping package including the height adjustable optical table as discussed above, wherein the base section, the top section, and the plurality of legs assemblies are detached from each other and are

Date Reçue/Date Received 2020-10-09

packed in one or more shipping containers. Another embodiment of the present invention provides a shipping package including a fully assembled height adjustable optical table.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1A – FIG. 1D illustrate a wide range of height requirements for an optical table to which equipment is mounted.

[0012] FIG. 2 illustrates a current optical table that is fully assembled, packed and stored as a compete assembly.

[0013] FIG. 3 is a modular motorized optical table package according to an embodiment.

[0014] FIG. 4A shows the connection between the moving and fixed assemblies, and FIG. 4B shows the details of the connection according to an embodiment.

[0015] FIG. 5 is an exploded view of an optical table according to an embodiment.

[0016] FIG. 6A and FIG. 6B are perspective views of an optical table according to an embodiment.

[0017] FIG. 7 is a cross-section view of a leg assembly according to an embodiment.

[0018] FIG. 8 shows a guidance system that prevents deflection according to an embodiment.

[0019] FIG. 9 shows the upper and lower assemblies of a guidance system according to an embodiment.

[0020] FIG. 10 shows the guidance pillars of a lower guidance assembly according to an embodiment.

Date Reçue/Date Received 2020-10-09

[0021] FIG. 11 shows the collision detector sensor and vibration isolator mechanism according to an embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] The description of illustrative embodiments according to principles of the present invention is intended to be read in connection with the accompanying drawings, which are to be considered part of the entire written description. In the description of embodiments of the invention disclosed herein, any reference to direction or orientation is merely intended for convenience of description and is not intended in any way to limit the scope of the present invention. Relative terms such as "lower," "upper," "horizontal," "vertical," "above," "below," "up," "down," "top" and "bottom" as well as derivative thereof (e.g., "horizontally," "downwardly," "upwardly," etc.) should be construed to refer to the orientation as then described or as shown in the drawing under discussion. These relative terms are for convenience of description only and do not require that the apparatus be constructed or operated in a particular orientation unless explicitly indicated as such. Terms such as "attached," "affixed," "connected," "coupled," "interconnected," and similar refer to a relationship wherein structures are secured or attached to one another either directly or indirectly through intervening structures, as well as both movable or rigid attachments or relationships, unless expressly described otherwise. Moreover, the features and benefits of the invention are illustrated by reference to the exemplified embodiments. Accordingly, the invention expressly should not be limited to such exemplary embodiments illustrating some possible non-limiting combination of features that may exist alone or in other combinations of features; the scope of the invention being defined by the claims appended hereto.

[0023] This disclosure describes the best mode or modes of practicing the invention as presently contemplated. This description is not intended to be understood in a limiting sense, but provides an example of the invention presented solely for illustrative purposes

Date Reçue/Date Received 2020-10-09

by reference to the accompanying drawings to advise one of ordinary skill in the art of the advantages and construction of the invention. In the various views of the drawings, like reference characters designate like or similar parts.

[0024] An object of an embodiment of the invention is to provide height adjustment of the optical tables or workstations from a seating position to a standing position and all positions in between, by providing approximately 300 mm of height adjustment in order to compensate for the varying requirements of the user.

[0025] In one embodiment, the optical table includes fixed and moving assemblies to provide the height adjustment as shown in Fig. 4A. Fig. 4B shows the details of the fixed and moving assemblies fitted with suitable connectors, couplers and/or mounting hardware for assembling according to an embodiment. As shown in Fig. 5, the optical table includes a base section 510, a top section 520 and four identical leg subassemblies 530 in each corner of the table which provide actuation for the height adjustment. In one embodiment, each of the leg subassembly includes a housing which is to be mounted to the base part of the optical table at one of the four corners. A motorized actuator is embedded in each of the leg subassemblies. The motorized actuator is able to extend and retract with the motion being supported by a number of guide pillars mounted to a rigid element within the table leg as shown in Fig 10 and corresponding upper moving tubes containing linear bearings mounted to the lifter assembly, see Fig 7. It is understood that the base section, top section, and leg subassemblies are fitted with suitable connectors, couplers and/or mounting hardware for assembling.

[0026] A control system includes a processor that controls the actuators in the leg subassemblies. When energized, the actuator within each leg subassembly extends in length, guided by the linear rails and bearings up to the maximum actuator extension, approximately 300 mm. Each of the four legs extends in synchronization via a user remote or interface device connected to the controller or processor. The user may position the table legs at any position in between the minimum and maximum actuator stroke lengths,

Date Reçue/Date Received 2020-10-09

being limited only by the minimum incremental movement capability of the control system. In one embodiment, a sensor configured to sense the position/extension of the shafts in the plurality of leg subassemblies. The processor uses the sensed signal to provide a closed loop control of the actuator. In one embodiment, the minimum and maximum stroke length of the actuators are controlled by sensors integral into the linear actuator.

[0027] Fig. 6A illustrates the situation where the height of the table is maximum when the legs are fully extended and Fig. 6B illustrates the situation where the height of the table is minimum when the legs are fully retracted.

[0028] In one embodiment, the acceleration and deceleration of the actuators are controlled by the controller or processor to minimize disturbances to the table and its contents as the height is adjusted (soft start/soft stop). In one embodiment, the actuators are low noise actuators to minimize disturbances to other users while the table is adjusted. In one embodiment, the actuators are low vibration actuators to minimize disturbances to the table content during height adjustment.

[0029] The leg subassemblies each consists of a linear actuator, the fixed portion of which is mounted to a rigid element within the table leg. Linear guides and linear bearings running parallel to the direction of actuator extension provide support to the moving part of the leg subassembly, resisting any side loads that may result from uneven loads on the table or torsion that may result from the reaction of the actuator.

[0030] Fig. 7 shows a cross-sectional view of a leg subassembly according to one embodiment. As shown in Fig. 8, when a leg is extended under load, side load may exert to the extended beam length, resulting in deflection. In one embodiment, a guidance system has been incorporated in the motorized actuator design in order to prevent the motorized electrical actuator component(s), i.e., lead screw directly imposed to the side loading during the heavy load placed on the optical table to maximum approximately equal to 700 kilogram and prevent it from the distortions and bent in principle. Hence it prevents considerable damages to the core mechanism used in the design.

Date Reçue/Date Received 2020-10-09

[0031] It also helps to move the lifter assembly to move vertically up and downwards inline to the axis of movement. In one embodiment, the actuators are rack-and-pinion-type actuators. The actuators are configured to prevent back driven if power to the motorized actuator is lost, so that the height of the table is maintained. In one embodiment, the actuator includes a locking mechanism, such that when a desired table height is reached, the actuators are locked in place from further movement. In other embodiments, the actuators are pneumatic, hydraulic, screw threads, or direct drive actuators, and some actuators are with cross links (i.e., scissor based lift).

[0032] Fig. 9 shows the guidance system with the upper guidance assembly being fitted to the lower guidance assembly according to an embodiment. The guidance system includes a lower guidance assembly having one or more pillars as shown in Fig. 10 and an upper guidance assembly having one or more corresponding tubes that are sized to fit the one or more pillars as shown in Fig. 11. The system is configured to have the guiding tubes or sleeves fitted in the upper assembly which slides over the lower guide assembly during the table surface moving up or downwards. In one embodiment, the guide system has guide pillars made up of stainless steel that is fixed in the solid locator in precisely bored holes in the locator with a locking provision that prevents the guide pillars moves out from its position.

[0033] To be useful, the surface on which an optical system is mounted must satisfy several basic requirements. First, it must provide a rigid base on which optics can be mounted and aligned reliably with long-term stability and no inherent vibrational resonances. It must not only successfully damp any vibrations caused by motorized or moving parts in the experiment, preventing these vibrations from influencing critical optical elements, but also isolate the experiment as a whole from ambient background laboratory vibrations. Fig. 11 shows an optical table fitted with an optional vibration isolator mechanism according to an embodiment.

Date Reçue/Date Received 2020-10-09

[0034] In one embodiment, the optical table includes passive vibration isolation optical table supports. These isolators provide simple and effective passive vibration isolation with excellent stability. The closed pneumatic isolation system can be inflated with a foot pump or some other source of compressed air that has a Schraeder valve. These isolators do not require a constant source of compressed air to maintain isolation. If the pneumatic isolation system is depressurized, the optical table will remain securely supported on and slightly isolated by the reinforced rubber air mount of the optical table supports.

[0035] In one embodiment, the optical table includes active vibration isolation optical table supports containing an isolation system that effectively isolates the optical table from vertical and horizontal vibrations. The vertical vibrations are isolated from the optical table by a dual-chamber pneumatic isolation system that requires a constant source of compressed air, such as an air compressor. The horizontal vibrations are isolated from the optical table by mounting the vertical isolation system on a suspension system.

[0036] When adjusting the height of the optical table, it is contemplated that a moving part of the optical table may collide with a stationary object. In one embodiment, the height adjustable optical table includes a collision detection system to detect a collision or imminent collision during the height adjustment (up or down) and to stop the power to the actuators. In one embodiment, the collision detection system generates an audio and/or visual signal to alert the user of a collision or imminent collision. In one embodiment, the collision detection system includes a sensor connected to the actuator controllers. It understood that the sensor may be any type of sensors suitable for detecting either an obstacle in a path of a moving part of the optical table or detecting a collision caused by the moving part of the optical table. For example, the sensor may be an optical sensor, touch sensor, limit switch sensor, proximity sensor, sonar sensor, accelerometer sensor, gyroscopic sensor, etc. Fig. 11 illustrates an optical table fitted with a collision detector sensor according to an embodiment.

Date Reçue/Date Received 2020-10-09

[0037] Some embodiments of the present invention have the following unique advantageous over existing optical tables:

- Compact height adjustable optical table.
- Modular design for easy handling, storage, shipping and maintenance.
- Ergonomic in operation.
- Clear family resemblance to the existing optical tables, such as the Thorlabs ScienceDesk product family.

[0038] While the present invention has been described at some length and with some particularity with respect to the several described embodiments, it is not intended that it should be limited to any such particulars or embodiments or any particular embodiment, but it is to be construed so as to provide the broadest possible interpretation in view of the prior art and, therefore, to effectively encompass the intended scope of the invention. Furthermore, the foregoing describes the invention in terms of embodiments foreseen by the inventor for which an enabling description was available, notwithstanding that insubstantial modifications of the invention, not presently foreseen, may nonetheless represent equivalents thereto.

Date Reçue/Date Received 2020-10-09

CLAIMS

1. A height adjustable optical table comprising:

a base section;

a top section;

a plurality of legs subassemblies, each leg subassembly comprising a housing; a motorized actuator configured to extend or retract, and being supported by a number of guide pillars and bearing assemblies;

a sensor configured to sense the positions of the motorized actuator in the plurality of leg subassemblies; and

a processor configured to control the actuators based on the sensed positions;

wherein the plurality of legs subassemblies are configured to have their housings mounted to the base section and to have their corresponding upper section mounted to the top section at their corresponding locations.

2. The height adjustable optical table of claim 1, wherein the motorized actuators are rack-and-pinion-type actuators, pneumatic actuators, hydraulic actuators, screw threads actuators, or direct drive actuators.

3. The height adjustable optical table of claim 1, wherein the processor is configured to control the motorized actuators such that the motorized actuators in the plurality of leg subassemblies are synchronously extended or retracted, such that the top section remains level during the extension or retraction.

4. The height adjustable optical table of claim 1, wherein the motorized actuators are extendable up to about 300 mm.

Date Reçue/Date Received 2020-10-09

5. The height adjustable optical table of claim 1, wherein each of the leg subassembly further comprises a guidance system configured to maintain the movement of the motorized actuator in the vertical direction.

6. The height adjustable optical table of claim 1, wherein each of the guidance system comprises a first guidance part having one or more pillars and a second guidance part having one or more corresponding tubes that are sized to fit the one or more pillars, such that the first guidance part can slide relative to the second guidance part.

7. The height adjustable optical table of claim 1, wherein the optical table is configured to support a maximum load of about 700 kg.

8. The height adjustable optical table of claim 1, wherein the processor is further configured to control an acceleration and deceleration of the extension and retraction movements.

9. The height adjustable optical table of claim 1, wherein the processor is further configured to avoid unbalanced operation by stopping the raising or lowering operation when the processor detects a power interruption or a fault in any of the actuators.

10. The height adjustable optical table of claim 1, further comprising an input device coupled to the processor, the input device is configured to receive inputs for table height adjustments.

11. The height adjustable optical table of claim 1, further comprising rigid, passive or active vibration isolator mounts.

Date Reçue/Date Received 2020-10-09

12. The height adjustable optical table of claim 1, further comprising a sensor configured to detect an obstacle in a path of a moving part of the optical table during a height adjustment, or to detect a collision caused by the moving part of the optical table.

13. A shipping package comprising the height adjustable optical table of claim 1, wherein the base section, the top section, and the plurality of legs subassemblies are detached from each other and are packed in one or more shipping containers.

14. A shipping package comprising the height adjustable optical table of claim 1, wherein the optical table is fully assembled.

Date Reçue/Date Received 2020-10-09

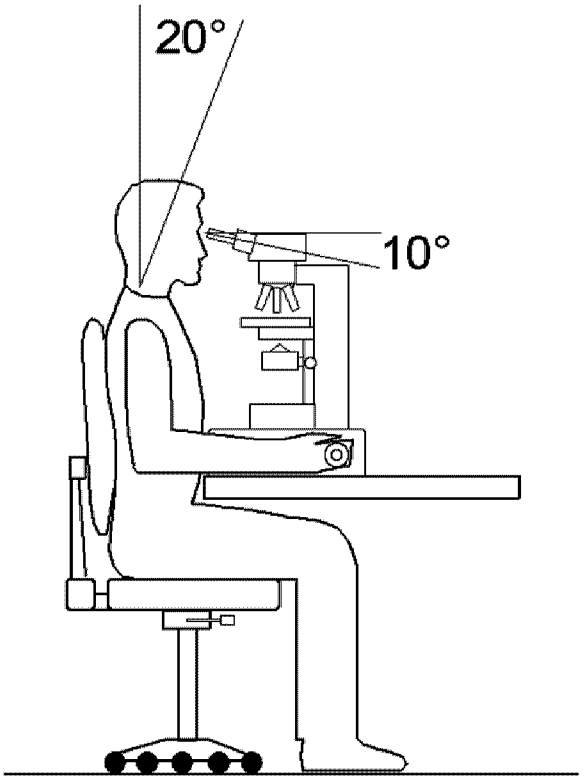


FIG. 1A

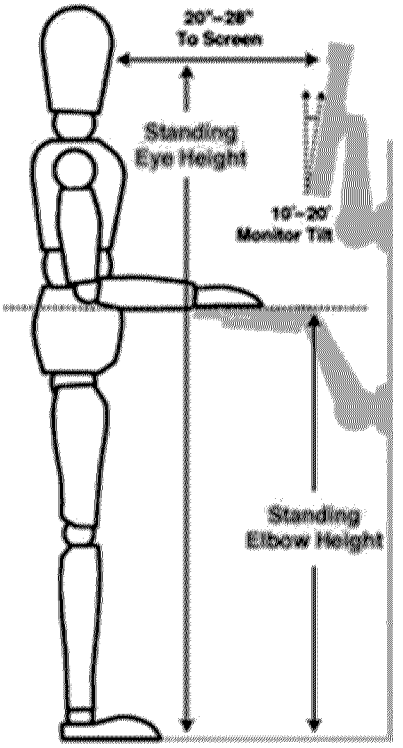


FIG. 1B

Date Reçue/Date Received 2020-10-09

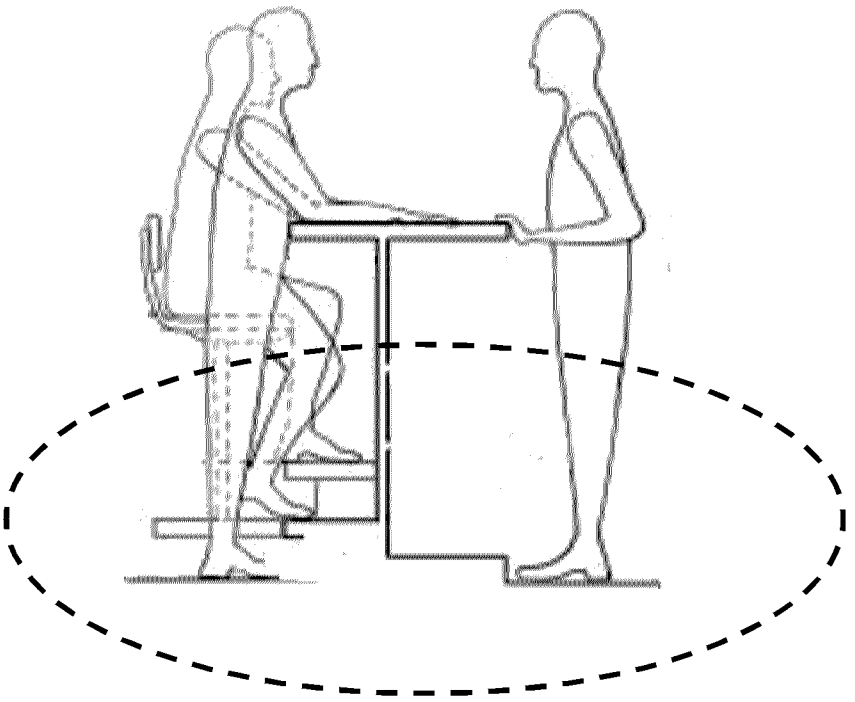


FIG. 1C

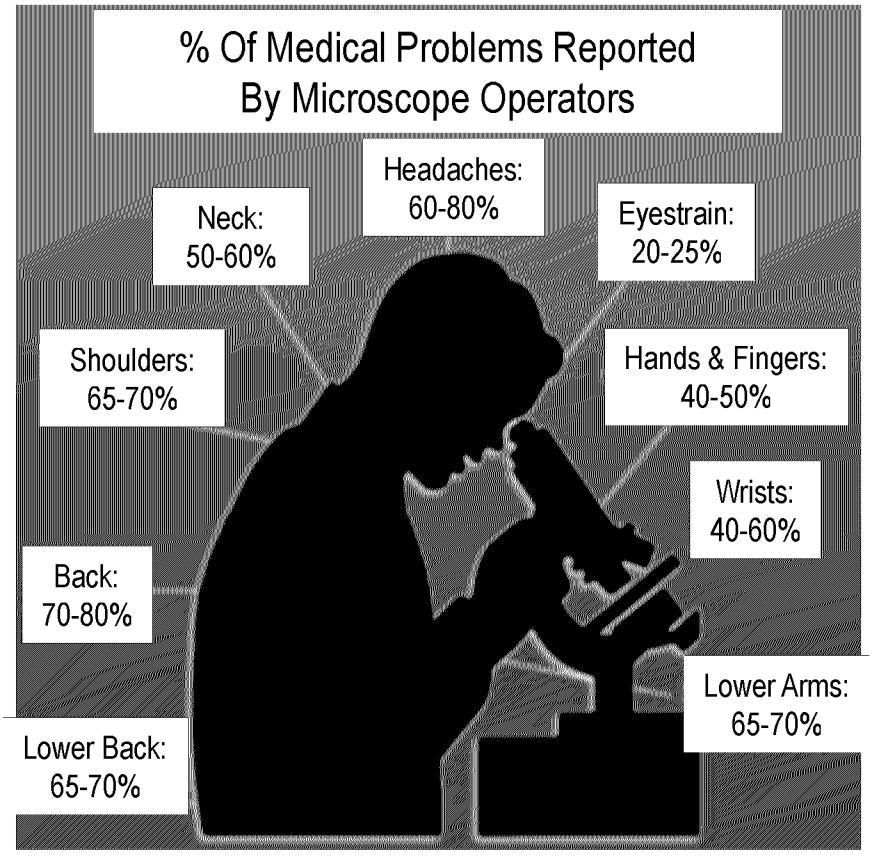

% Of Medical Problems Reported
By Microscope Operators
Headaches:
60-80%
Neck:
50-60%
Eyestrain:
20-25%
Shoulders:
65-70%
Hands & Fingers:
40-50%
Wrists:
40-60%
Back:
70-80%
Lower Arms:
65-70%
Lower Back:
65-70%

FIG. 1D

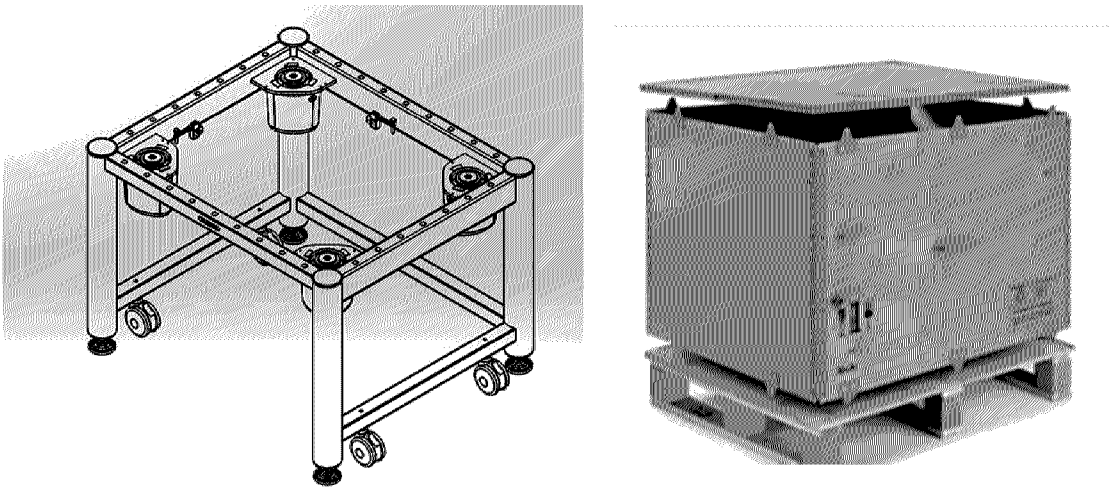


FIG. 2

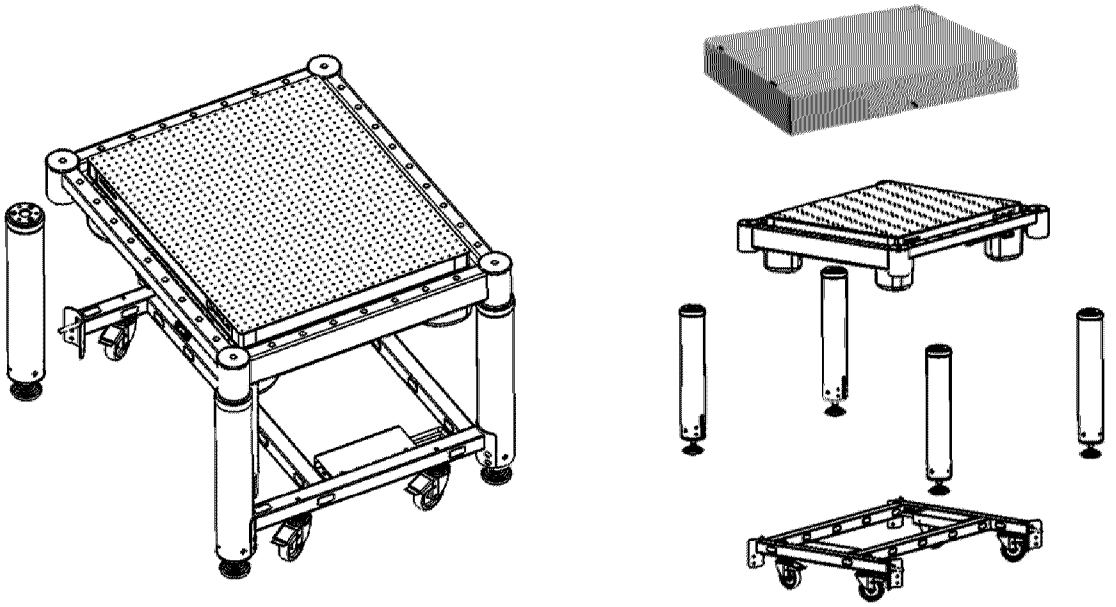


FIG. 3

Date Reçue/Date Received 2020-10-09

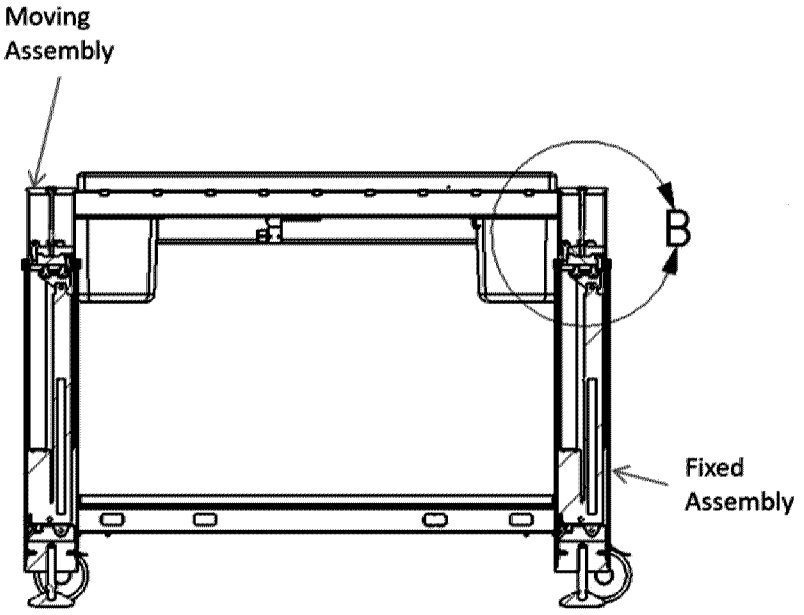


FIG. 4A

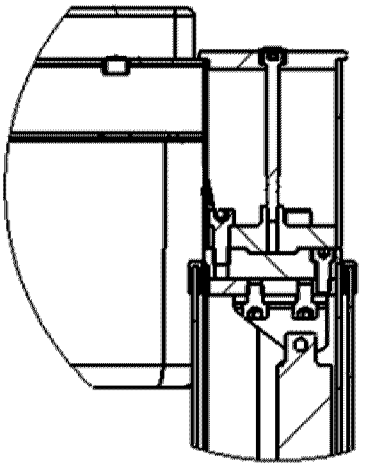


FIG. 4B

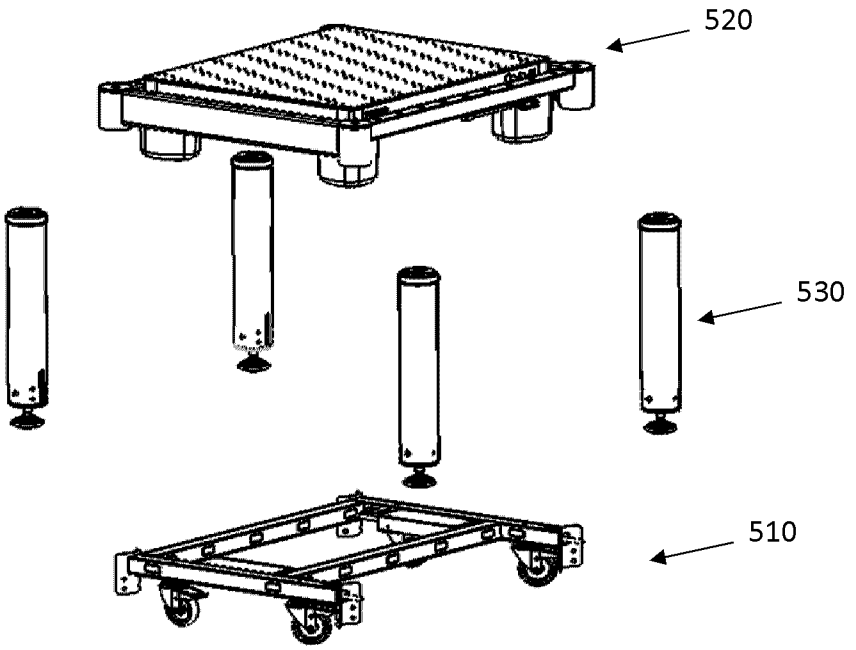


FIG. 5

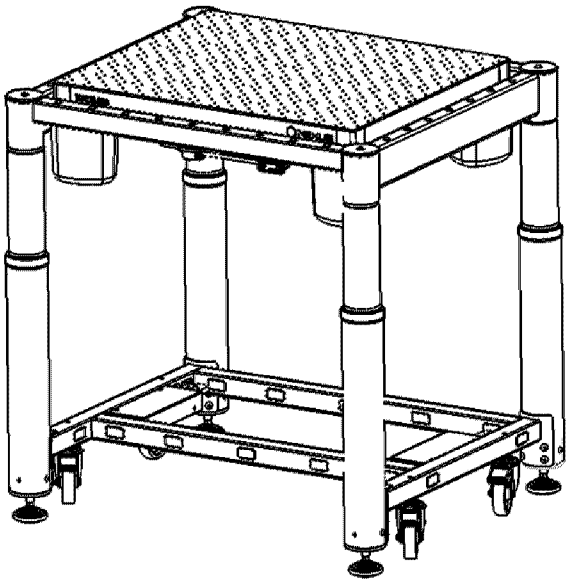


FIG. 6A

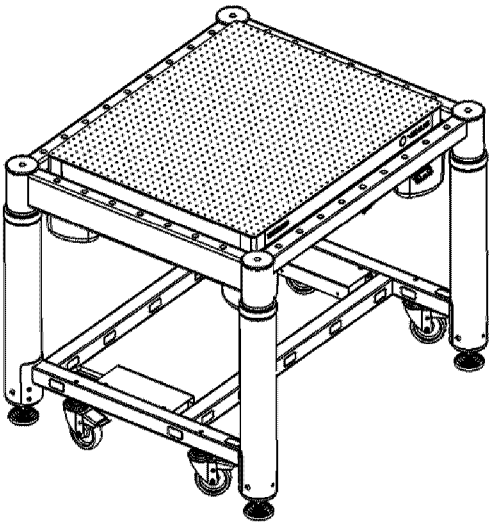


FIG. 6B

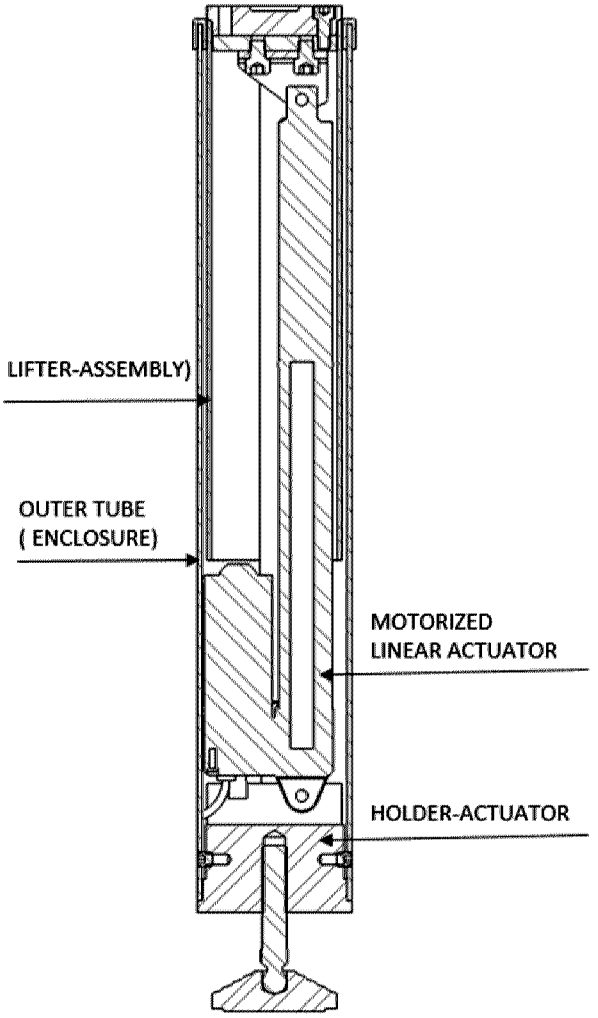


FIG. 7

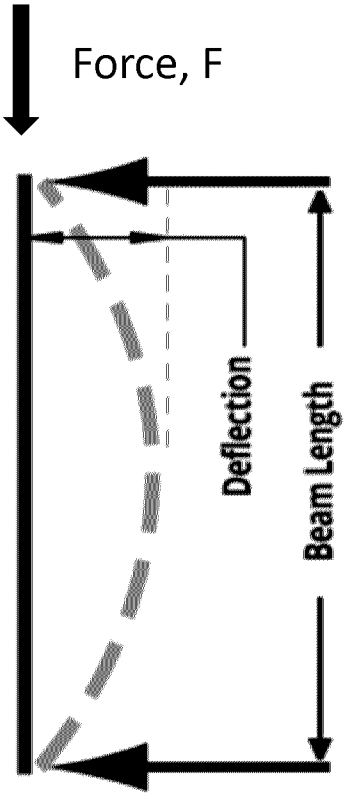


FIG. 8

Date Reçue/Date Received 2020-10-09

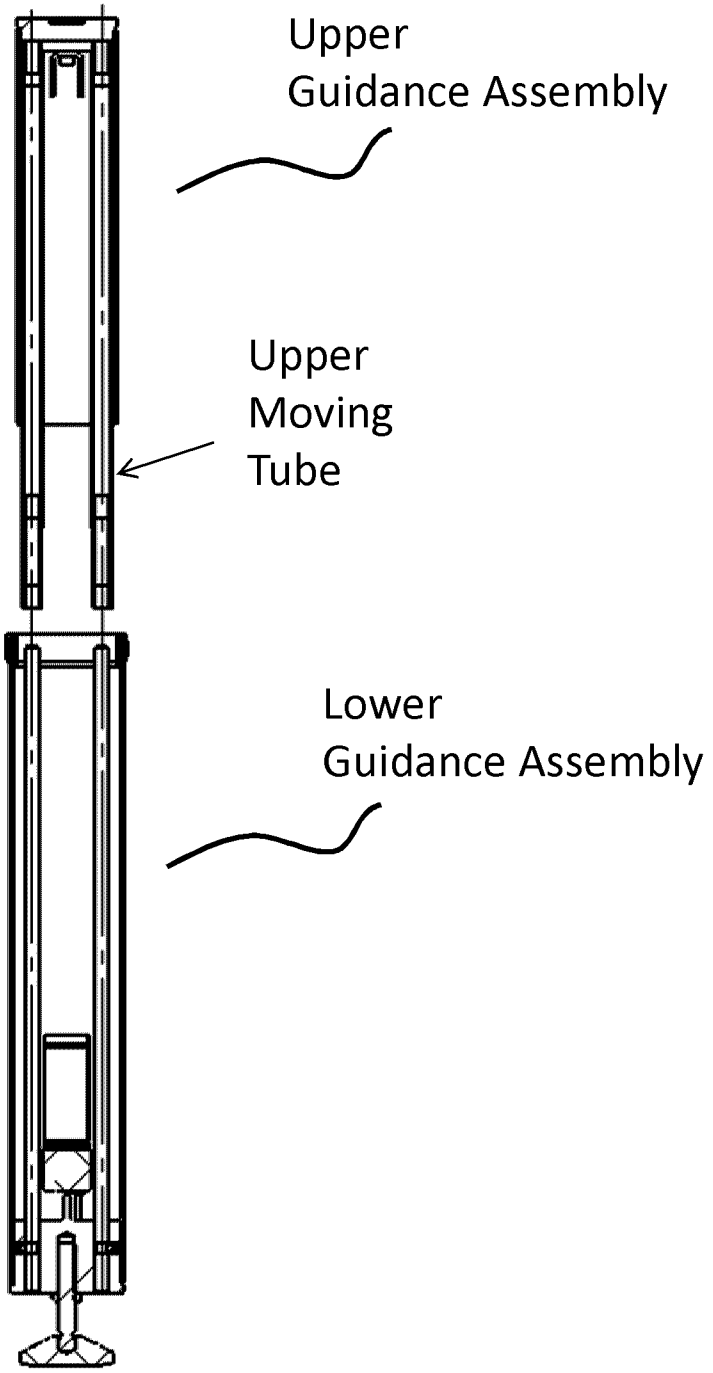


FIG. 9

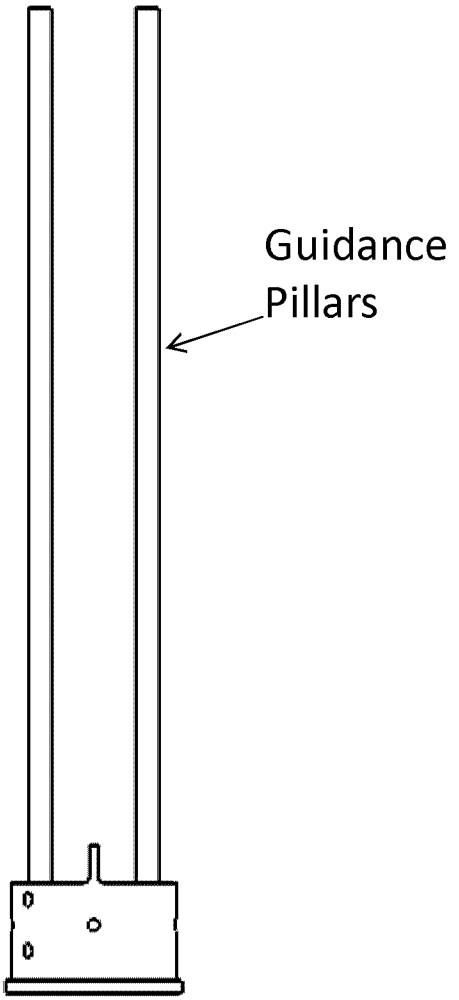


FIG. 10

Date Reçue/Date Received 2020-10-09

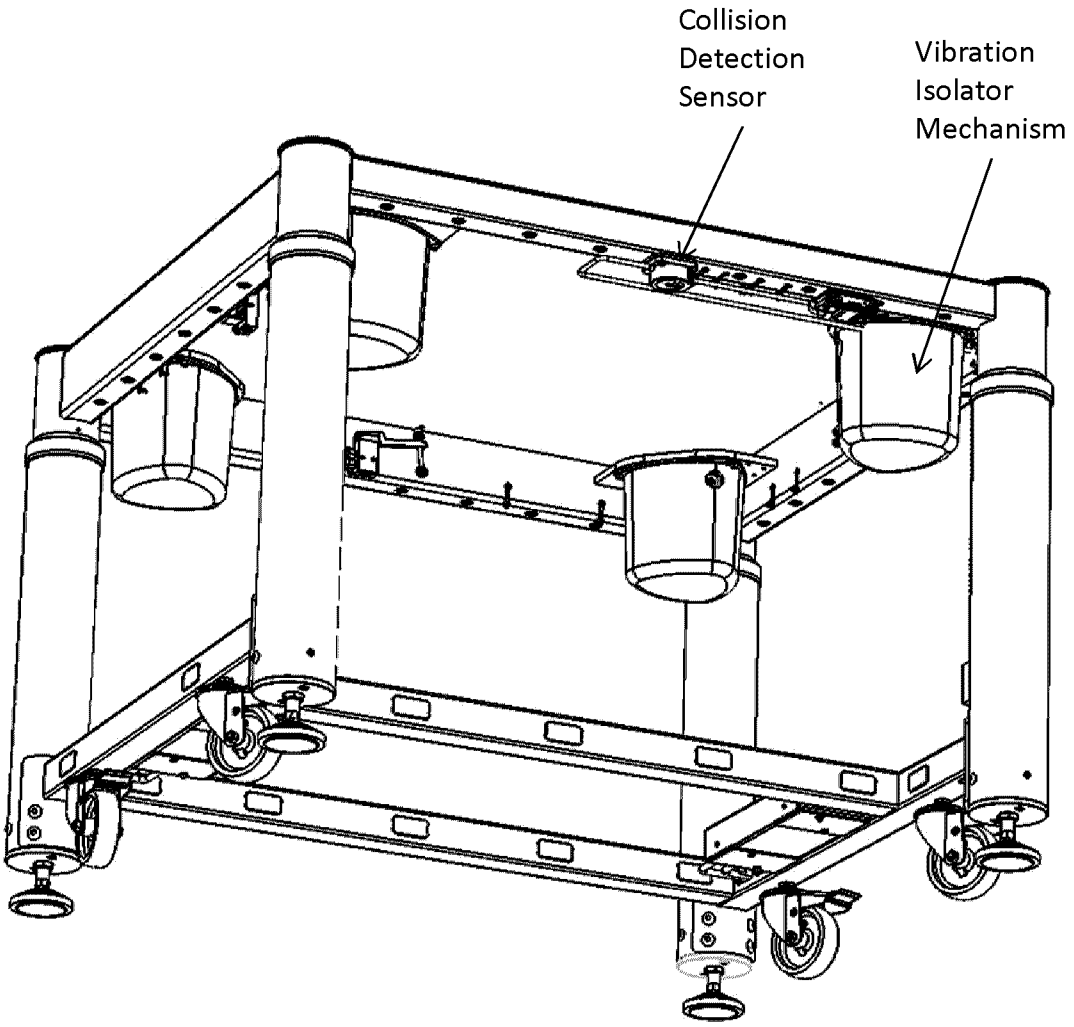


FIG. 11

Date Reçue/Date Received 2020-10-09