

CLASS 901, ROBOTS**SECTION I - CLASS DEFINITION****CROSS-REFERENCE ART COLLECTIONS**

This collection provides for a reprogrammable, multi-function manipulator designed to move devices through variable programmed motions for the performance of changeable tasks on a repetitive basis without human intervention and all subcombinations thereof specialized for use with such manipulator.

SECTION II - NOTES TO THE CLASS DEFINITION

- (1) Note. It should be noted that this is a cross-reference collection of art only and not a true "Class" within the meaning of that term as used in the U.S. Patent Classification System although it is a search tool which is a part of that system. This collection will not, therefore, take for original placement any U.S. Patent.
- (2) Note. A robot usually has an arm* (elongated appendage) which normally has three degrees of freedom*.
- (3) Note. A robot must be reprogrammable to perform a variety of different tasks. Thus, a numerically controlled machine tool which may have an arm, but is designed to perform only a fixed set of tasks, is not a robot.
- (4) Note. Subcombinations (e.g., programs, actuators, joints, grippers, bearings, gears, etc.) have been included in all instances where there was a disclosure basis (e.g., for use in an industrial robot, programmable manipulator, etc.). Some subcombinations, of general utility (e.g., containing no specific statement of use with a robot in the disclosure), are also included, where in the opinion of the Classifiers, the subcombination is readily adaptable for use in a robot. An attempt has been made to provide search notes for pertinent subcombinations of more general utility.
- (5) Note. This cross-reference art collection provides a general locus for all information relating to robot machines or subcombina-

tions and elements peculiar thereto, regardless of the type of work which is done by that machine. Based upon past development of the system of patent classification, such patents are to be found in many classes, their disposition being dependent on a number of diverse considerations. The most pertinent classifications for subject matter dealing with robots have been screened; however, it should be noted that this cross-reference collection represents the initial attempt to collect this subject matter and therefore should not be construed as being the exhaustive locus for robot machines in its present form.

- (6) Note. This drawings associated with the definitions are merely used to illustrate the basic concept encompassed by the definition of each subclass, and should not be construed as limiting the scope of the subject matter covered by any subclass.

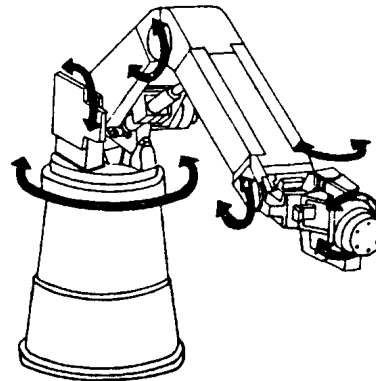


Fig. 1 Industrial robot

SECTION III - REFERENCES TO OTHER CLASSES**SEE OR SEARCH CLASS:**

- 29, Metal Working, subclass 26 for a drill press, subclasses 33+ and 563 for a conveying means used in a metal working apparatus which includes metal shaping and for assembly, and subclasses 701+ for assembly devices.
- 118, Coating Apparatus, subclasses 696 through 698 for a programmed paint spraying or coating device.

- 166, Wells, subclasses 338+ for a tool which acts in an underwater environment.
- 178, Telegraphy, subclasses 18+ for program controlled arms for writing.
- 219, Electric Heating, subclasses 124.1+ and 125.1+ for automatic electric arc welding devices.
- 228, Metal Fusion Bonding, subclass 7 for programmed welding devices and subclass 45 for processes involving the use of programmed welding devices.
- 239, Sprinkling, Spraying, and Diffusing, subclass 69 for programming means for a paint spraying device.
- 294, Handling: Hand and Hoist-Line Implements, subclass 66 for underwater handling implements and subclasses 86+ for gripping devices, per se.
- 318, Electricity: Motive Power Systems, subclass 162 and 560+ for motor systems.
- 364, Electrical Computers and Data Processing Systems, subclasses 191+ for programming systems, subclasses 474.01+ for computer applications to machining, subclasses 478.01+ for computer applications to material handling.
- 395, Information Processing System Organization, subclasses 80+ for robot control.
- 414, Material or Article Handling, subclasses 1 through 8 and art collection 909 for remotely controlled manipulators (e.g., master-slave), subclasses 22.51+ for well pipe racking, subclass 146 for the charging or discharging of material into a radioactive environment, subclass 186 for furnace charging or discharging devices having a grab, subclasses 589+, 591, 730+, 744.1+, 749.1, and 754+ for article handlers described by their movement through space and art collection 917 for material handlers having parallel links.
- 483, Tool Changing, generally for a process or apparatus including a tool transfer means combined with either a tool support or a storage means.
- 623, Prosthesis (i.e., Artificial Body Members), Parts Thereof, or Aids and Accessories Therefor, subclass 60, 61 and 64 for artificial arms parts having structure similar to robot arm* parts.

The appendage emanating from the base* of the robot and running to, but not including the end effector*.

BASE

The supporting structure for the arm*.

DEGREE OF FREEDOM

Each linear or rotary movement along or about a given axis.

END EFFECTOR

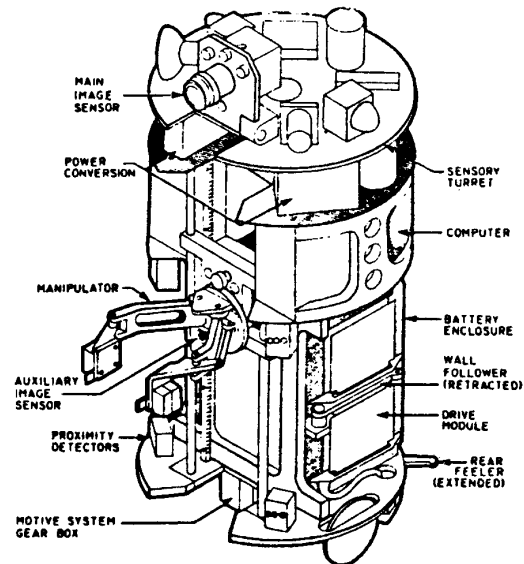
A device connected to the distal end of the robots arm* which carries out the robots intended function.

SUBCLASSES

1 MOBILE ROBOT:

Subject matter under the cross-reference collection definition including a base* which is programmable to move without restraint.

- (1) Note. A robot with a base* which is guided for movement along a track so that the base* must follow the trackway is not considered to be a mobile robot.



SECTION IV - GLOSSARY

ARM

SEE OR SEARCH THIS CLASS, SUB-CLASS:

14+, for track guided robots.

SEE OR SEARCH CLASS:

172, Earth Working, subclass 3 for automatic motive power control of an earth working machine.

446, Amusement Devices: Toys, subclasses 269+ for a wheeled figure toy. These devices are ordinarily not reprogrammable.

2 ARM MOTION CONTROLLER:

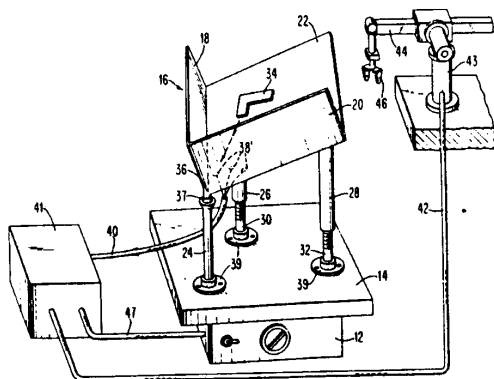
Subject matter under the cross-reference collection definition including means for sending signals to a drive system for the arm*.

(1) Note. A device in this and in indented cross-reference subcollections represents, in human terms, the brain and nervous system of the robot. The controller will perform one or more of the following functions:

a. storing, sequencing and positioning data in memory.

b. initiating and stopping the motions of the arm*.

c. interacting with the external environment.



SEE OR SEARCH THIS CLASS, SUB-CLASS:

20, for significant structure for varying the velocity of an arm* component.

SEE OR SEARCH CLASS:

228, Metal Fusion Bonding, subclass 7 for an arm motion controller for a welding device and subclass 102 for processes involving the arm motion controller of a welding device.

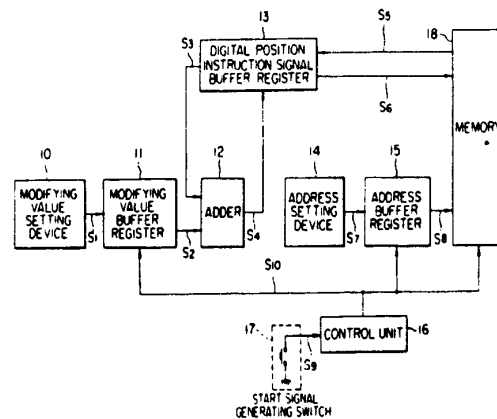
318, Electricity: Motive Power Systems, appropriate subclasses for arm motor systems.

364, Electrical Computers and Data Processing Systems, subclasses 474.01+ for computer applications for machining, subclasses 478.01+ for computer applications for material handling.

395, Information Processing System Organization, subclasses 80+ for arm motion control systems.

3 Teaching system:

Subject matter under cross-reference subcollection 2 for designing and/or inputting a work pattern into the controller so that the robot may perform work without human intervention.



SEE OR SEARCH CLASS:

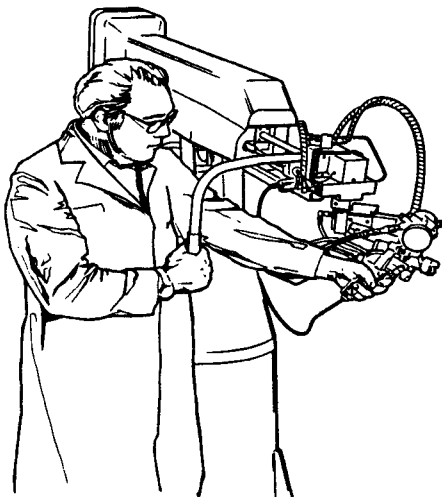
29, Metal Working, subclasses 701+ for programming means for an assembly device.

- 318, Electricity: Motive Power Systems, subclass 568 for program recording means and subclass 162 for prerecorded tapes or drums.
- 364, Electrical Computers and Data Processing Systems, subclasses 191+ for the preparation of computer programs, generally.
- 395, Information Processing System Organization, subclasses 80+ for the preparation of computer programs for control of a robot arm.

4 Manual lead through:

Subject matter under cross-reference subcollection 3 in which an operator moves the arm* by hand through all positions required to do the task and the controller stores the position of the arm* in memory.

- (1) Note. Teaching may be done at a speed difference from that needed for real time operation, i.e., playback may be set at other speeds, allowing for different cycle times.

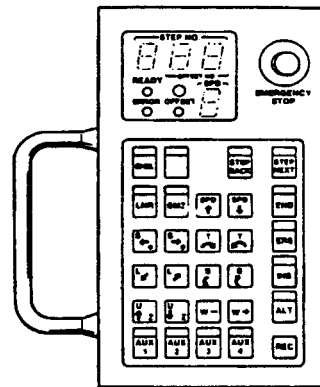


5 Machine driven lead through:

Subject matter under cross-reference subcollection 3 in which the arm*, during the teaching operation, is controlled by either a teaching pendant or a separate computer terminal.

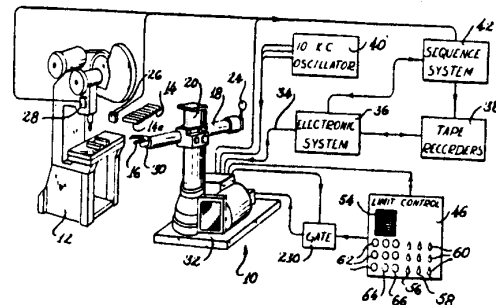
- (1) Note. A teach pendant is a device similar to a remote control box with the addi-

tional capability to record and play back stored commands.



6 Communication with another machine:

Subject matter under cross-reference subcollection 2, wherein another machine exchanges information with the arm* motion controller.



SEE OR SEARCH CLASS:

- 29, Metal Working, subclass 563 for a conveying device cooperating with a metal working machine and subclass 26 for a conveying device cooperating specifically with a drill press.
- 72, Metal Deforming, subclass 405, 420+ and 422 for a conveying cooperating with a metal deforming machine.
- 409, Gear Cutting, Milling or Planing, subclass 7 for a gear cutting device combined with work transfer utilizing a transfer arm and subclasses 172+ for a milling machine combined with a work transfer means.

SEE OR SEARCH THIS CLASS, SUB-CLASS:

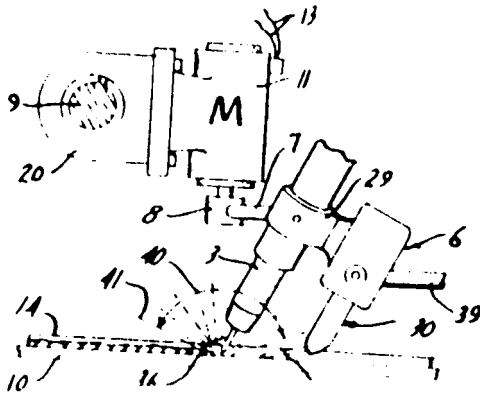
- 32, for servo actuated gripping jaws.
- 46, for sensors, per se, usable with robots.

SEE OR SEARCH CLASS:

- 56, Harvesters, subclasses 10.2+ and Digest 15 for a condition responsive controlled harvesting arm.
- 318, Electricity: Motive Power Systems, subclasses 560+ for positional servo systems.

10 Sensor physically contacts and follows work contour:

Subject matter under cross-reference subcollection 9 wherein the sensor is biased into surface contact with the work and is caused to travel thereover to thereby cause the arm* to maintain a fixed relative position with respect to said work surface.



SEE OR SEARCH CLASS:

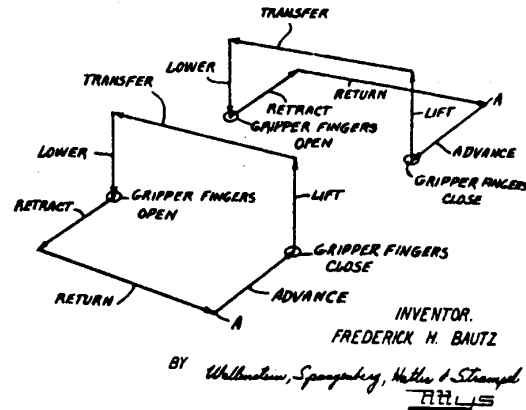
- 219, Electric Heating, subclass 124.1 for electric arc welding with automatic positioning of the arc and subclasses 125.1+ for electric arc welding having a predetermined welding operation (programmed controlled).
- 228, Metal Fusion Bonding, subclass 7 for the guiding of a welding device and subclass 102 for a process involving the guiding a welding device.

11 Mechanically actuated present limit:

Subject matter under cross-reference subcollection 2 including mechanical means for caus-

ing termination of movement of an arm* component at its programmed end.

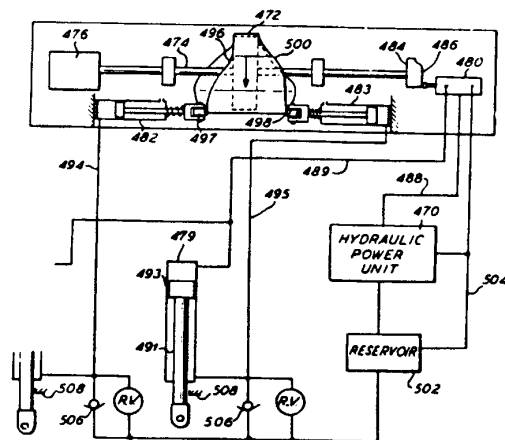
- (1) Note. There are usually only two positions for each component of the arm* to assume: up/down, left/right, extend/retract, as differentiated from a closed loop system (see (1) Note. in subcollection 9).



12 Cam:

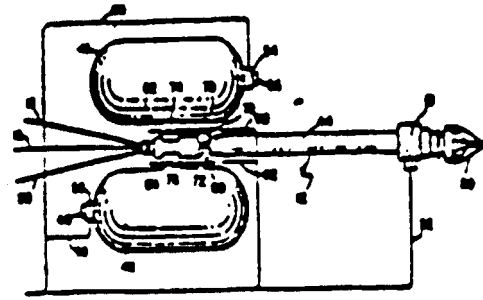
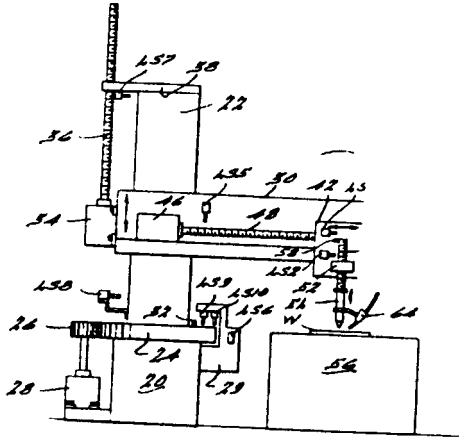
Subject matter under cross-reference subcollection 11 wherein said means includes a cam and a cam follower.

- (1) Note. Included herein are cam drives wherein the disengagement of the cam drive terminates arm* movement.



13 Limit switch:

Subject matter under cross-reference subcollection 11 wherein said means comprises a mechanically actuated electric switch.



SEE OR SEARCH THIS CLASS, SUBCLASS:

29, for wrist movements.

SEE OR SEARCH CLASS:

172, Earth Working, subclasses 3+ for the movement of an earth working machine about a stationary base and particularly subclass 26 for a track guided earth working machine.

414, Material or Article Handling, subclass 539 for a load support with linear vertical movement and additional movement for aligning and mounting a load at a specific location, subclass 591 for a guided hoist with a load supporting grab moveable horizontally by means which swings horizontally or moves linearly, subclasses 680+ for a vertically swinging load support, subclass 744 for a horizontally swinging load support, subclasses 749+ for a load supported mounted horizontal linear movement, subclass 776 for a reorienting device mounted on an arm which is swingable about its transverse axis and rotatable about its longitudinal axis, and cross-reference art collection 917 for a handling device having parallel links.

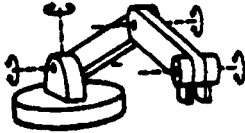
14 ARM* MOVEMENT (SPATIAL):

Subject matter under the cross-reference art collection definition characterized by the manner in which the arm* moves through space due to its structure thereby giving the robot its various degrees of freedom*.

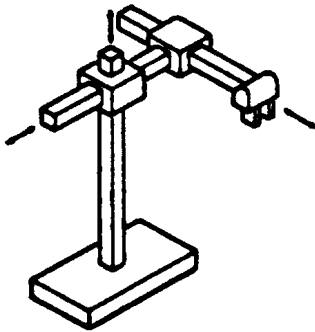
- (1) Note. Robot arms* may have linear movement along or rotary movement about a given axis. The robot arm* movement through space in this and indented subcollections is usually determined by the relative number of linear vs. rotary joints.
- (2) Note. In this and indented subclasses, the motion of the wrist has not been considered in determining placement.

15 Jointed:

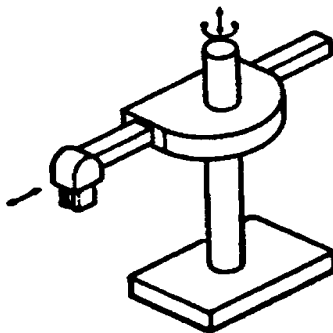
Subject matter under cross-reference subcollection 14 wherein the arm* has at least three degrees of freedom* which are constituted by rotary joints.



- 16 Cartesian (X - Y - Z arm):**
Subject matter under cross-reference subcollection 14 wherein the arm* has at least three degrees of freedom* which are constituted by orthogonally related linear movements.

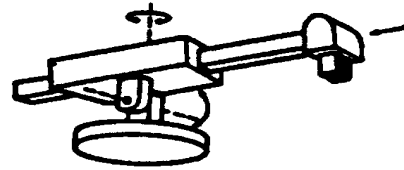


- 17 Cylindrical:**
Subject matter under cross-reference subcollection 14 wherein the arm* has at least three degrees of freedom*, one of which is rotary, the other two being constituted by orthogonally related linear movements.

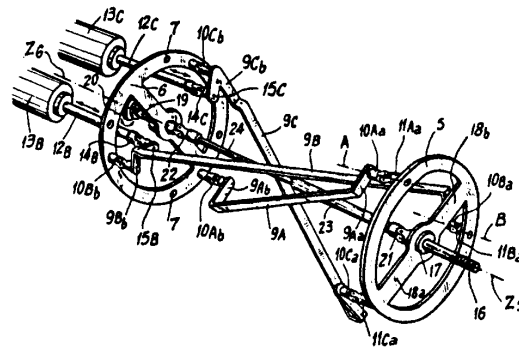


- 18 Spherical:**
Subject matter under cross-reference subcollection 14 wherein the arm* has at least three

degrees of freedom*, two or which are orthogonally related rotary joints and the third is a linear movement.



- 19 DRIVE SYSTEM FOR ARM:**
Subject matter under the cross-reference collection definition characterized by a motor which drives the arm* and/or by the transmission of that motion from the motor to the arm*.



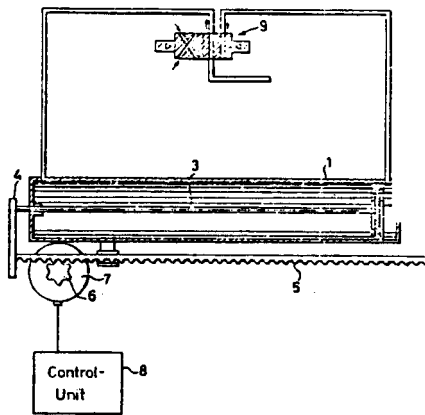
SEE OR SEARCH THIS CLASS, SUB-CLASS:

- 12, for cam driven drive systems for the arm*.

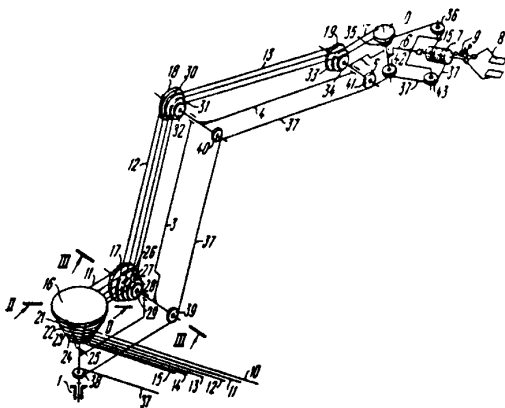
SEE OR SEARCH CLASS:

- 623, Prosthesis (i.e., Artificial /body Members), Parts Thereof, or Aides and Accessories Therefor, subclass 60 for an elbow joint with forearm actuation in a prostheses.

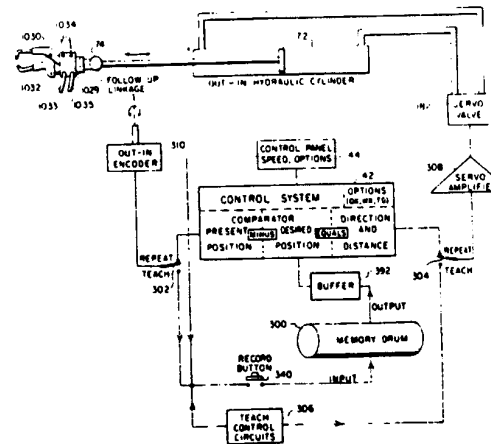
- 20 Provision for altering speed of driven element:**
Subject matter under cross-reference subcollection 19 wherein particular means associated with the motor or transmission is provided for varying the velocity of movement of an arm* component during its stroke.



21 Flaccid drive element:
 Subject matter under cross-reference subcollection 19 wherein the transmission of motion between the driving motor and the arm* includes a belt, chain or cable.



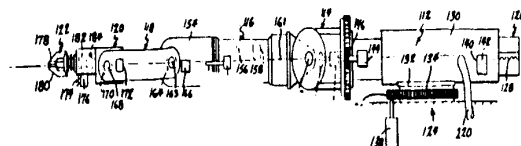
22 Fluid motor:
 Subject matter under cross-reference subcollection 19 wherein the motor which drives the arm* converts hydraulic or pneumatic pressure into mechanical work.



SEE OR SEARCH THIS CLASS, SUB-CLASS:
 37, for fluid actuated gripping jaws.

SEE OR SEARCH CLASS:
 623, Prosthesis (i.e., Artificial Body Members), Parts Thereof, or Aides and Accessories Therefor, subclass 26 for fluid actuated prostheses.

23 Electric motor:
 Subject matter under cross-reference subcollection 19 wherein the motor which drives the arm* converts electrical energy into mechanical work.



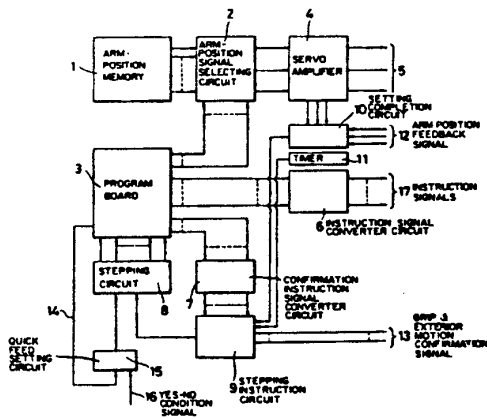
SEE OR SEARCH THIS CLASS, SUB-CLASS:
 38, for electrically actuated gripping jaws.

SEE OR SEARCH CLASS:
 318, Electricity: Motive Power Systems, appropriate subclasses for electric motor control.

623, Prosthesis (i.e., Artificial Body Members), Parts Thereof, or Aids and Accessories Therefor, subclasses 24+ for electrically actuated prostheses.

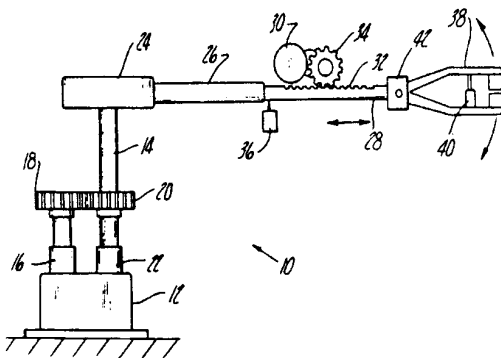
24 Stepper motor:

Subject matter under cross-reference subcollection 23 wherein the electric motor which drives the arm* produces discrete increments when excited by an input pulse.



25 Gearing:

Subject matter under cross-reference subcollection 19 wherein the transmission of motion from the motor to the arm* is accomplished by a system which includes first and second relatively rotatable bodies provided with teeth or other interengaging drive surfaces and wherein motion is imparted from the first to the second body by rolling contact.

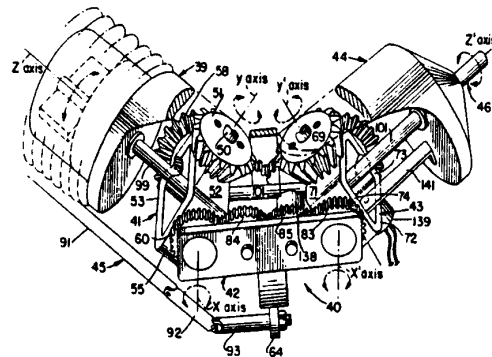


SEE OR SEARCH CLASS:

- 74, Machine Element or Mechanism, subclasses 640+ for gearing, per se.
- 475, Planetary Gear Transmission Systems or Components, for planetary gear transmissions.

26 Including bevel gear:

Subject matter under cross-reference subcollection 25 wherein the interengaging drive surfaces are at an angle which intersects the rotational axis of the bodies.

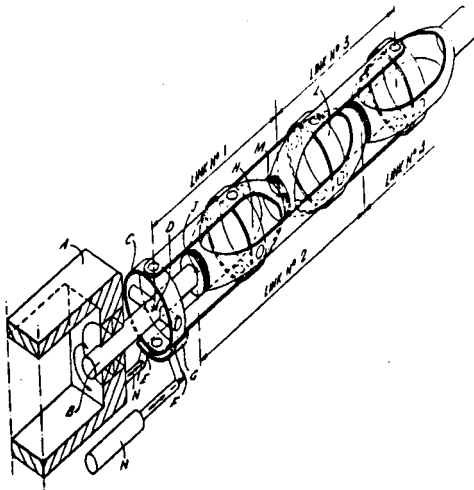


SEE OR SEARCH CLASS:

- 74, Machine Element or Mechanism, subclasses 640+ for bevel gearing, per se.
- 475, Planetary Gear Transmission Systems or Components, for planetary gear transmissions using bevel gears.

27 ARM PART:

Subject matter under the cross-reference definition characterized by the structure of a mechanical link or the connection between adjacent links which form the robot arm*.

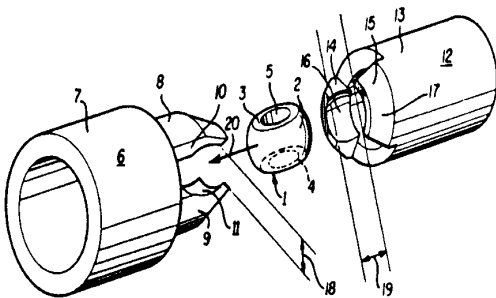


SEE OR SEARCH CLASS:

- 74, Machine Element or Mechanism, subclasses 469+ for linkages, per se.
- 414, Material or Article Handling, cross-reference art collection 917 for a handling device having parallel links.

28 Joint:

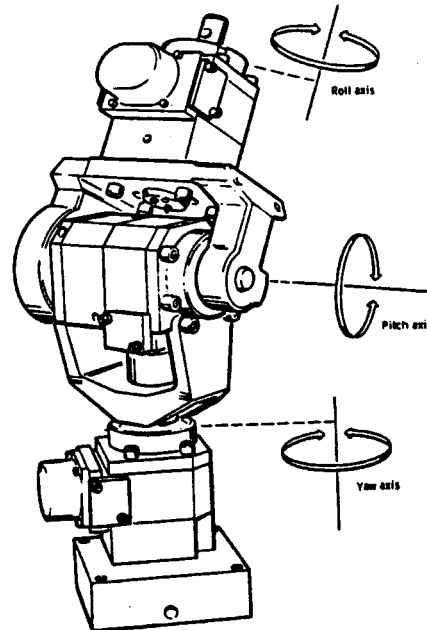
Subject matter under cross-reference subcollection 27 wherein significance is attributed to the connection between the mechanical links of the arm*.



29 Wrist:

Subject matter under cross-reference subcollection 28 wherein significance is attributed to the particular joint located at a distal end of the robot arm* which connects that arm with an end effector*.

- (1) Note. Wrist action usually provide the robot with an even greater amount of flexibility. In addition to the three degrees of freedom* provided by the robots arm*, the wrist can provide an extra three degrees of motion. These articulations are commonly referred to as yaw, pitch and roll.



SEE OR SEARCH CLASS:

- 414, Material or Article Handling, subclasses 732+ and 738+ for a grab moveable relative to its vertically swinging supporting arm and subclass 776 for a reorienting device which is swingable about its transverse axis and rotatable about its longitudinal axis.
- 623, Prosthesis (i.e., Artificial Body Members), Parts Thereof, or Aides and Accessories Therefor, subclass 65 for wrist actuation in a prosthesis.

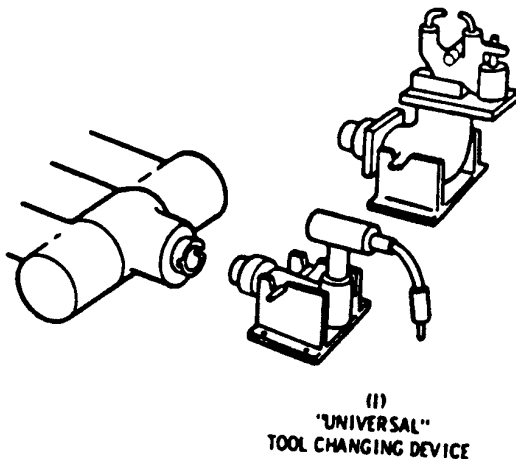
30 END EFFECTOR:

See the glossary of terms under the cross-reference collection definition.

- (1) Note. The end effector* is commonly the only hardware element which needs to

be changed to adapt the robot to a new task. The end effector* is considered separate from the robot itself, is mounted on its own flange, and usually requires an independent means of being actuated and powered, although its actions are coordinated by the robots controller.

- (2) Note. Included in this subclass are tool changing robots and special connecting devices for the attaching of the end effector* to the robot arm*.



SEE OR SEARCH CLASS:

- 29, Metal Working, subclasses 701+ for programmed assembly devices for tool changers.
- 165, Heat Exchange, subclass 76 for devices which repair or aid in the assembly of heat exchange.
- 178, Telegraphy, for programmed arms with a writing device as the end effector.
- 483, Tool Changing, cross-reference art collection 901 for robot end effectors.

31 Gripping jaw:

Subject matter under cross-reference subcollection 30 adapted to transport an object wherein opposed grasping elements are moveable relative to each other to grip the object therebetween.

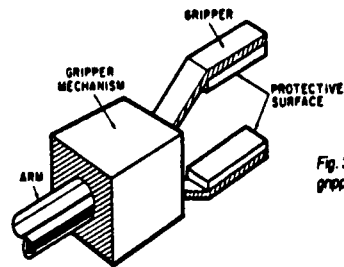


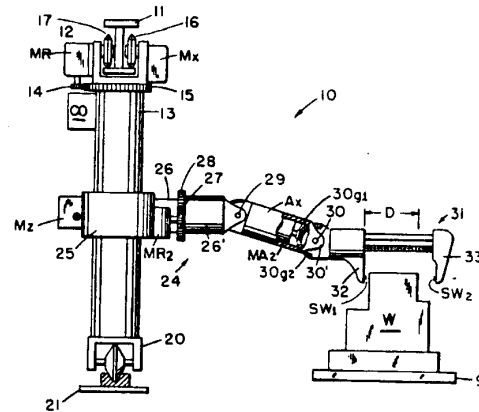
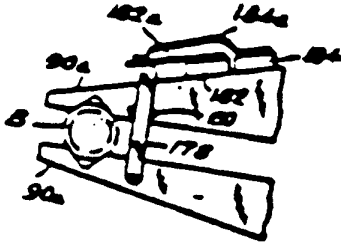
Fig. 3. Diagram of a typical gripper attachment.

SEE OR SEARCH CLASS:

- 72, Metal Deforming, subclass 422 for a gripper which handles work in a metal deforming apparatus.
- 198, Conveyors: Power-Driven, subclass 486 for reciprocating or oscillating gripping devices used to move a load from one conveyor section to another.
- 294, Handling: Hand and Hoist-Line Implements, subclass 86.4 for grappling elements of more general utility.
- 364, Electrical Computers and Data Processing Systems, subclasses 478.01+ for computer applications of material handling devices.
- 414, Material or Article Handling, subclass 186 for a furnace charging device having a gripper, subclasses 225+ for an article handling which selects a load from a source and delivers the load to a working, treating or inspecting station, subclasses 730+ for a material handling grab mounted for vertical swinging movement, subclasses 744.1+ for a material handler mounted for horizontal swinging movement, subclasses 751.1 and 753.1 for a material handling gripper mounted for horizontal linear movement, subclass 763 for a gripping device which inverts an article, and subclass 783 for a gripper on an article reorienting device in general.
- 623, Prosthesis (i.e., Artificial Body Members), Parts Thereof, or Aides and Accessories Therefor, subclass 64 for a finger actuator embedded in a simulated hand.

32 Servo-actuated:

Subject matter under cross-reference subcollection 31 and further including a sensor located on the robot which controls movement of a grasping element.



SEE OR SEARCH THIS CLASS, SUB-CLASS:

- 9, for a sensor actuated feedback loop which controls arm* movement.
- 46, for sensing devices per se usable with robots.

SEE OR SEARCH CLASS:

- 56, Harvesters, subclasses 10.2+ and Digest 15 for a condition responsive controlled harvesting device.

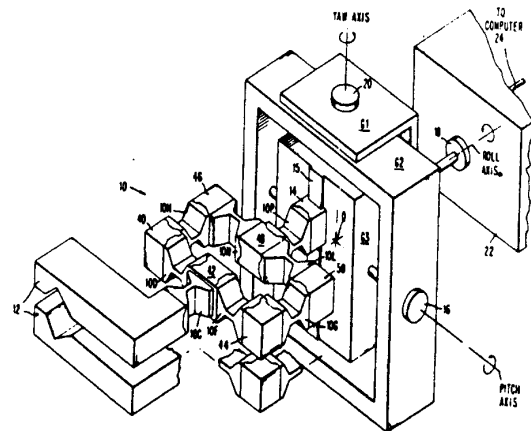
33 Tactile sensor:

Subject matter under cross-reference subcollection 32 wherein the sensor is located on a grasping element and senses an object grasped thereby by direct contact therewith.

- (1) Note. These devices may use simple switches as sensors, or pressure sensitive materials, or the sensors may feel surface contours.

34 Force feedback:

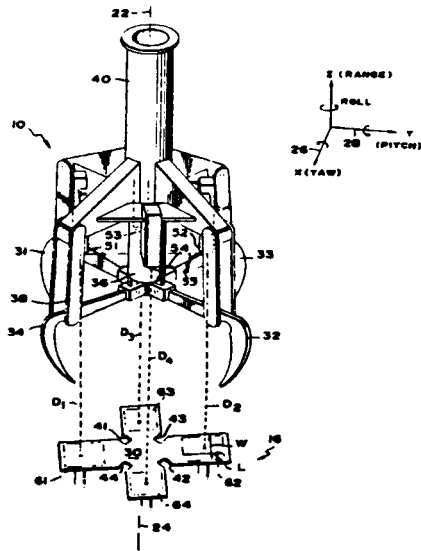
Subject matter under cross-reference subcollection 32 wherein the sensor is at a location spaced from a grasped object and includes means to sense strain on the grasping element.



35 Proximity:

Subject matter under cross-reference subcollection 32 wherein the sensor includes means to sense the relative position between the grasping element and an object to be grasped.

- (1) Note. Sensors in this subcollection include optical interrupters (LED's), reflective, electromagnetic and ultrasonic.



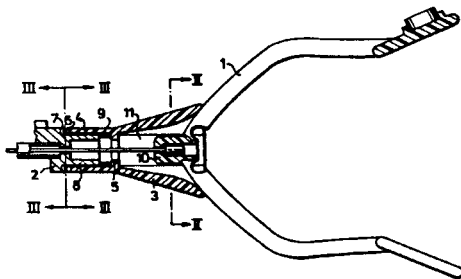
SEE OR SEARCH CLASS:

343, Communications: Radio Wave Antennas, subclass 7 for radio wave proximity detectors.

367, Communications, Electrical: Acoustic Wave, Systems and Devices, subclass 96 for acoustic wave proximity detectors.

36 Actuating means:

Subject matter under cross-reference subcollection 31 wherein significance is attributed to the means for moving the grasping element.

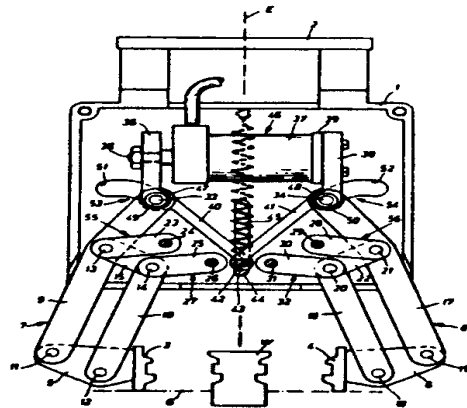


SEE OR SEARCH THIS CLASS, SUBCLASS:

19+, for motors which drive robotic arms*.

37 Fluid motor:

Subject matter under cross-reference subcollection 36 wherein said means utilizes hydraulic or pneumatic pressure.



SEE OR SEARCH THIS CLASS, SUBCLASS:

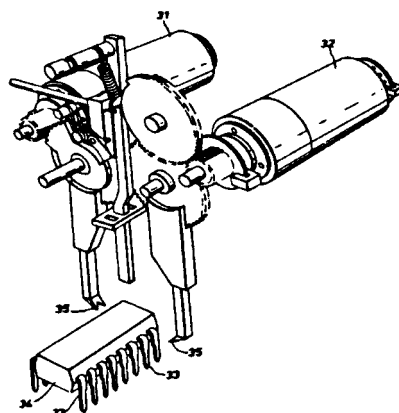
22, for a fluid motor which drives a robotic arm*.

SEE OR SEARCH CLASS:

623, Prosthesis (i.e., Artificial Body Members), Parts Thereof, or Aides and Accessories Therefor, subclass 26 for a fluid actuated prosthesis.

38 Electric motor:

Subject matter under cross-reference subcollection 36 wherein said means utilizes electrical energy.

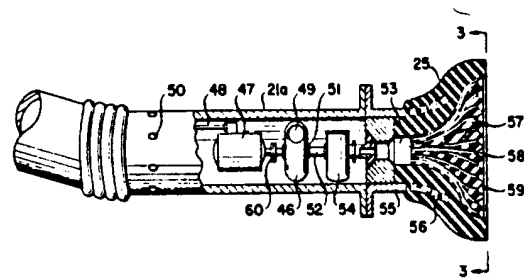


SEE OR SEARCH THIS CLASS, SUB-CLASS:

23, for an electric motor which drives a robotic arm*.

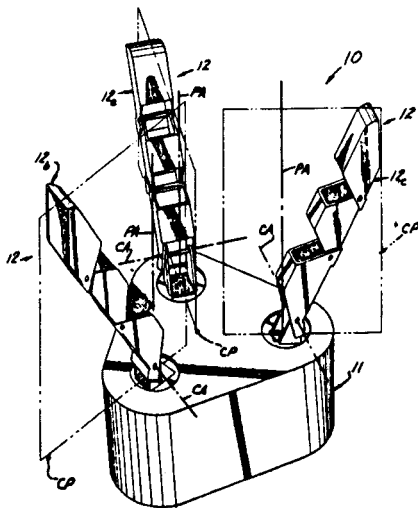
SEE OR SEARCH CLASS:

623, Prosthesis (i.e., Artificial Body Members), Parts Thereof, or Aides and Accessories Therefor, subclasses 24+ for electrically actuated prosthesis



39 Jaw structure:

Subject matter under cross-reference subcollection 31 wherein significance is attributed to the physical configuration of the grasping element.



40 Vacuum or magnetic:

Subject matter under cross-reference subcollection 30 which includes a vacuum cup, permanent magnet or an electromagnet for the purpose of handling material.

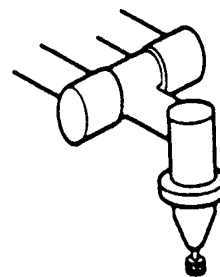
SEE OR SEARCH CLASS:

294, Handling: Hand and Hoist-Line Implements, subclasses 64+ and 65.5 for vacuum and magnet means associated with implements for handling articles.

414, Material or Article Handling, subclass 437 for a suction or magnetic device mounted on a vertically swing-load support, subclass 744 for a suction or magnetic device mounted on a horizontally swinging load support, and subclass 752.1 for a suction device mounted for horizontal linear movement.

41 Tool:

Subject matter under cross-reference subcollection 30 wherein the device is a work treating element.



(F)
ROUTER OR DEBURRING DEVICE

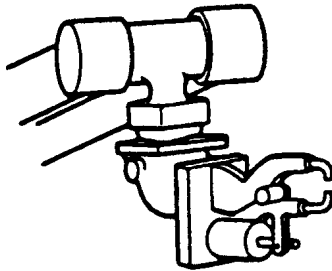
SEE OR SEARCH CLASS:

451, Abrading, subclasses 2+ for condition responsive sandblasting devices.

42 Welding:

Subject matter under cross-reference subcollection 41 wherein the element performs a welding operation.

- (1) Note. This provides a collection of the so-called "welding robots".



(D) SPOTWELDING GUN

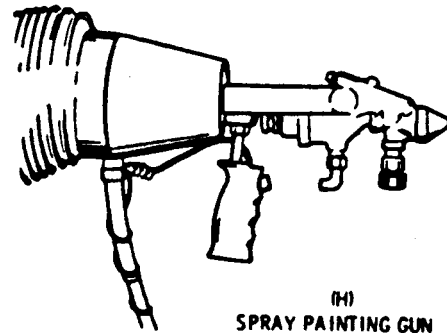
SEE OR SEARCH CLASS:

- 219, Electric Heating, subclass 124.1 for electric arc welding with automatic positioning of the arc and subclass 125.1 for electric arc welding having a predetermined welding operation (programmed controlled).
- 228, Metal Fusion Bonding, subclass 7 for welding robots and subclass 102 for processes involving the use of a programmed welding device.

43 Spray painting or coating:

Subject matter under cross-reference subcollection 41 wherein the element performs a painting or coating operation.

- (1) Note. This provides a collection of the so-called "spray painting robots".



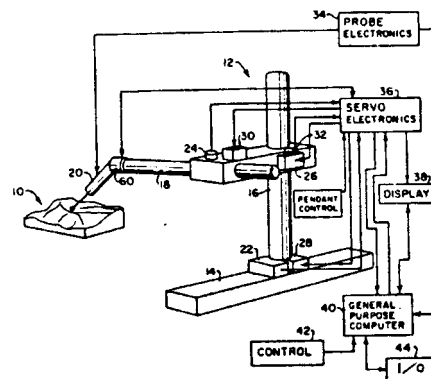
(H) SPRAY PAINTING GUN

SEE OR SEARCH CLASS:

- 118, Coating Apparatus, subclasses 696 through 698 for program controlled paint spraying or coating.
- 239, Sprinkling, Spraying, and Diffusing, appropriate subclasses for a painting device and particularly subclass 69 for programming means for controlling fluid flow.

44 Inspection:

Subject matter under cross-reference subcollection 30 said device being a sensor adapted to sense conditions on an object being scanned by the robot.



SEE OR SEARCH THIS CLASS, SUBCLASS:

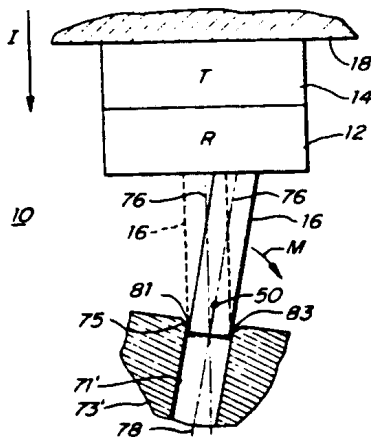
- 46, for sensing devices, per se.

SEE OR SEARCH CLASS:

- 165, Heat Exchange, for remotely controlled inspection means for heat exchangers.
- 376, Induced Nuclear Reactions: Processes, Systems, and Elements, subclass 249 for nuclear reactor vessel monitoring or inspecting.

45 **Compliance:**

Subject matter under cross-reference subcollection 30 which include a means for aiding insertion and mating maneuvers by permitting the device to adapt to misalignments.

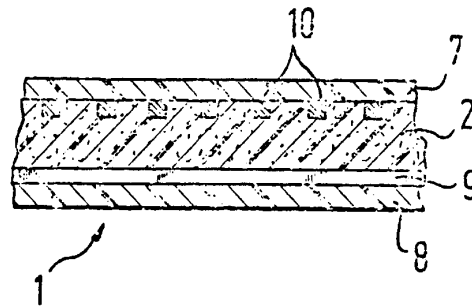


SEE OR SEARCH CLASS:

- 33, Geometrical Instruments, subclass 169 and 185 for compliance devices, per se.

46 **SENSING DEVICE:**

Subject matter under the cross-reference collection definition comprising a sensor which is usable on a robot.



SEE OR SEARCH THIS CLASS, SUB-CLASS:

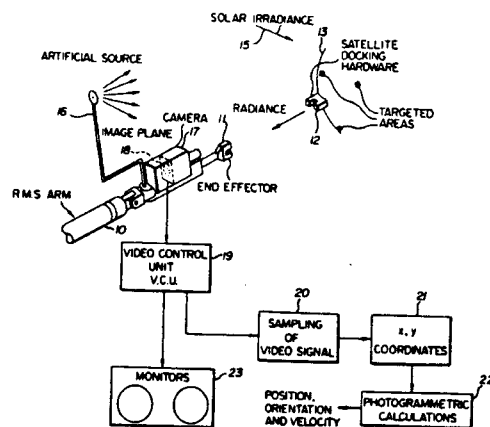
- 9+, for sensing devices in combination with a robotic arm* motion controller.
- 32+, for sensing devices which cause activation of gripping jaws.
- 44+, for sensing devices used as end effectors* in inspection robots.

SEE OR SEARCH CLASS:

- 343, Communications: Radio Wave Antennas, subclass 7 for radio wave proximity detectors.
- 367, Communication, Electrical Acoustic Wave Systems and Devices, subclass 96 for acoustic wave proximity detectors.

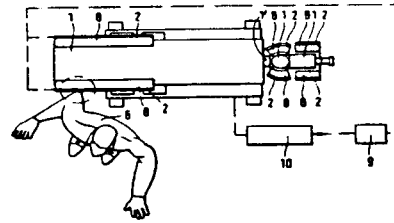
47 **Optical:**

Subject matter under cross-reference subcollection 46 which includes means sensitive to light rays.



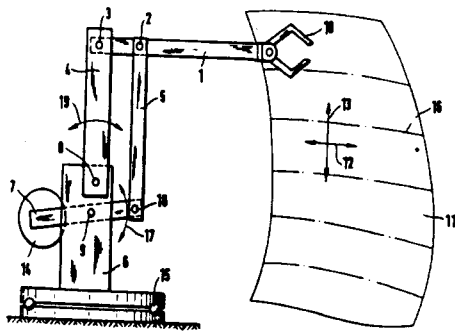
SEE OR SEARCH CLASS:

356, Optics: Measuring and Testing, subclass 28 for sensors which optically measure velocity, subclasses 139.04 through 139.08, 141.1 through 141.5 and 152.1 through 152.3 for optical sensors which measure angles or misalignment, and subclass 400 for optical sensors which measure alignment in a lateral direction.



48 COUNTERBALANCE:

A device under the cross-reference collection definition including means to balance the weight of the robot arm* or a load carried thereby.

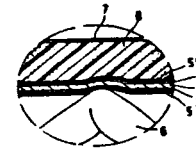


SEE OR SEARCH CLASS:

414, Material or Article Handling, subclass 673 for a counterweight on a handling device.

49 PROTECTIVE DEVICE:

Subject matter under the cross-reference collection definition which either (1) prevent human beings from being injured by a robot or (2) prevent the robot itself from being damaged.



50 MISCELLANEOUS:

Subject matter under the cross-reference collection definition not provided for elsewhere.

END