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(54) **Self-piercing type rivet setting system**

System zum Stanznieten

Système de rivetage autoperforant

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Description

[0001] The present invention relates to a self-piercing type rivet setting system, and in more particular, to a self-piercing type rivet setting system suitable to cooperate with an electrically controlled system, such as a robot which is used when two sheets or three or more sheets of plate members (or a plate member and a part) are riveted using a self-piercing type rivet in a sheet metal assembling operation, for example, in a car body assembling operation (especially in an aluminum body assembling operation).

[0002] An exemplary self-piercing type rivet setting system has been disclosed in Japanese Patent Publication No. 08-505087. Fig. 1 thereof shows an exemplary self-piercing type rivet. The self-piercing type rivet is formed with a flange-like head portion and two legs extending from the head portion. When the rivet is driven by a punch and die into a workpiece to be riveted, for example, into two sheets of body panels, the legs deform at their tips to be expanded while piercing the panels thus to couple the panels with each other by the expanded leg portion and the head portion. A self-piercing type rivet is suitable for coupling of aluminum body members for which the welding cannot be made, and further, demand for a self-piercing type rivet is expected since more aluminum body members will be prospectively employed for a car body member to meet an increasing requirement for a weight reduction thereof.

[0003] Though not disclosed in the above patent document, a conventional self-piercing type rivet setting system driven by oil pressure or electric power comprises an independent rivet swaging assembly and a jig or robot as a means for moving the rivet swaging assembly to put it in position relative to a predetermined site to be riveted on a workpiece. The rivet swaging assembly is mounted on a front end of an arm of the robot or jig. Such conventional apparatus needs, in addition to the rivet swaging assembly for the self-piercing type rivet and an controller therefor, a jig or robot and another controller for controlling the jig or robot to be driven, which has made a cost of an arrangement expensive. Further, in a facility where a robot or jig moves the rivet swaging assembly to the working sites, the rivet swaging assembly has a built-in driving unit therein, so as to make its volume as a whole bulky. Yet further, an interface cable extending from the controller to the rivet swaging assembly has interfered with complexity in geometry of a car body and the like, leaving some sites unavailable to be riveted.

[0004] US-A-4 662 556 describes a device for assembling by riveting two or more sections of a sheet element structure wherein the sections to be assembled are supported in a fixed stationary mode. A guide beam is clamped firmly against one side of the sections and supports a selectively movable working unit driven by pressurized air and comprising drilling machines and rivet supplying and installing means and a riveting hammer.

A multiple or single point thrust and rivet bucking means is arranged on opposite side of the sections and comprises clamping force producing thrust elements and a rivet bucking die. A computerized control system comprising a portable central unit governs the operation cycles of the working unit as well as the thrust and rivet bucking means. One part of the control system and a small computer terminal are carried on the main frame of the working unit.

[0005] Accordingly, an object of the present invention is, in a self-piercing type rivet setting system operated by a moving means of a rivet swaging assembly such as a robot or a jig, to save an expense for an arrangement, to reduce a size thereof, and to reduce a number of cables.

[0006] The object of the present invention described above has been achieved by a self-piercing type rivet setting system comprising: a rivet swaging assembly for setting a self-piercing type rivet, said swaging assembly comprising a C-shaped frame, a die mounted to one end and a punch mounted to other end of said C-shaped frame, a means for movably supporting said punch, said means comprising an electric drive motor and a mechanism coupled with said motor for moving said punch in a linear direction; a first controller for controlling a riveting operation of the rivet swaging assembly; an articulated robot for moving the rivet swaging assembly to put it in position relative to a predetermined site to be riveted on a workpiece; a second controller for controlling an operation of said articulated robot; and a rivet feeder for automatically feeding a self-piercing type rivet to the rivet swaging assembly; and wherein the first controller also controls a feeding of the self-piercing type rivet from the rivet feeder; the self-piercing type rivet setting system is characterized in that the first controller is incorporated into the second controller to be formed into a single integrated controller, and the rivet swaging assembly is integrally incorporated into said articulated robot. It should be noted that from the integrated controller, one interface cable extends to the articulated robot and another interface cable to the rivet feeder.

[0007] In the self-piercing type rivet setting system described above, the C-shaped frame may be mounted on a front end of an arm of the articulated robot. Further the electric drive motor may be fixedly mounted on the front end of the robot arm and a link arm may be coupled with the motor for moving the punch in a linear direction, which allows a mechanical structure of a riveting function portion to be made more compact.

[0008] A preferred embodiment of the invention will now be described with reference to the following drawings of which:

Fig. 1 is a schematic diagram of a self-piercing type rivet setting system according to the prior art; and Fig. 2 is a schematic diagram of a self-piercing type rivet setting system according to the present invention.

[0009] Prior to giving a detailed description of a preferred embodiment according to the present invention, a conventional self-piercing type rivet setting system 1 will be described with reference to Fig. 1. Referring to Fig. 1, the conventional self-piercing type rivet setting system 1 comprises: a rivet swaging assembly 2 for setting a self-piercing type rivet; a first controller 3 for controlling a riveting operation of the rivet swaging assembly 2; a robot 6 (or a jig) as a moving means for moving the rivet swaging assembly 2 to put it in position relative to a predetermined site to be riveted on a panel 5 as a workpiece; a second controller 7 for controlling an operation of the robot 6; and a rivet feeder 9 for automatically feeding a self-piercing type rivet to the rivet swaging assembly 2. Further, the first controller 3 also controls the feeding of the self-piercing type rivet from the rivet feeder 9. The first controller 3 has a first interface cable 10 which is connected to the rivet swaging assembly 2 to control the rivet swaging assembly 2, a second interface cable 11 which is connected to the rivet feeder 9 to control the rivet feeder 9, and further a third interface cable 13 which is connected to the second controller 7 to provide for cooperation between the motion of the rivet swaging assembly 2 and that of the robot 6 for riveting operation. The second controller 7 has, in addition to the third interface cable 13 connected to the first controller 3, a fourth interface cable 14 which is connected to the robot 6 (or a jig) as a rivet swaging assembly moving means to control the robot 6 or the like. Further, a feeding tube 15 extends from the rivet feeder 9 to a receiver mechanism 17 located in a head portion of the rivet swaging assembly 2 for successively feeding the self-piercing type rivets one after another to the rivet swaging assembly 2. Since the feeding operation of the rivet from the rivet feeder 9 is performed using compressed air, the rivet feeder 9 is supplied with compressed air through a pipe 18.

[0010] The rivet swaging assembly 2 comprises: a C-shaped frame 21 mounted on a front end of an arm 19 of an articulated robot 6; a die 22 mounted to one end (a lower end in the illustrated embodiment) of the C-shaped frame 21; a punch 23 mounted to other end (upper end) of the C-shaped frame 21, the punch 23 opposed to the die 22 so as to be capable of moving into contact with/away from the die 22; and an electric drive motor 25 for movably supporting the punch 23 allowing the punch 23 to move into contact with/away from the die 22. The electric motor 25 has a shaft with a lead screw formed thereon to apply a force to the punch 23 to strongly press the self-piercing type rivet held in the punch 23 into the die 22 side. Reversing the rotation of the electric motor 25 can retract the punch 23. The self-piercing type rivet fed from the receiver mechanism 17 is held on the tip of the punch 23. The C-shaped frame 21 is advantageously formed so as to pinch the panels to be riveted or swaged at a riveting site thereof between the punch 23 and the die 22, each being located in an upper or a lower side respectively.

[0011] The first controller 3, in order to control a riveting operation of the rivet swaging assembly 2, has: a first function of controlling the electric drive motor 25; a second function of measuring a riveting pressure applied to the punch 23 by the electric motor 25 and a displacement thereof based on a signal from a sensor (not shown), and determining whether or not the measured value falls within a predetermined range; and a third monitor function of measuring, prior to a riveting operation, a length of the self-piercing type rivet and a thickness of the panel 5 as a workpiece to be riveted. Those functions are transmitted between the first controller 3 and the rivet swaging assembly 2 through the first interface cable 10. The first controller 3 has another function of controlling the rivet feeder 9 through the second interface cable 11, and also the first controller 3 sends a control signal over the fourth interface cable 14 to the second controller 7 for controlling the rivet swaging assembly moving means such as the robot 6 (or a jig) so as to adaptively act to the operation of the rivet swaging assembly. To the fourth interface cable 14, various signals are also sent from the second controller 7 for cooperative actuation between the rivet swaging assembly 2 and the robot 6.

[0012] In operation, the self-piercing type rivet is sent from the rivet feeder 9 to the receiver 17 by a command from the first controller 3 and the rivet is held in the punch 23. On the other hand, the second controller 7, based on a signal from the first controller 3, sends a command to the robot 6 so that prior to the riveting operation, the robot moves the C-shaped frame 21 to a position where the punch 23 and the die 22 are to pinch the panel 5 as a workpiece to be riveted at a predetermined site thereof to place the rivet swaging assembly 2 in position. After this positioning of the rivet swaging assembly 2, the electric drive motor 25 of the rivet swaging assembly 2 is actuated and then, the punch 23 applies the pressure onto a head portion of the rivet in a direction toward the die 22, so that leg portions of the rivet pierce through the first panel of the two panels and further into the second panel until they stop piercing in mid course where the tip portion of the leg deforms to be expanded, thereby to couple the panels to each other by this expanded leg portion and the head portion of the rivet. This coupling procedure is illustrated in, for example, Fig. 1 of the Japanese Patent Publication No. 08-505087. Following to this riveting operation, the rotation of the motor reverses to retract the punch 23, and the next self-piercing type rivet is fed to the receiver mechanism 17 to complete the preparation for the next riveting operation. The self-piercing type rivet setting system 1 according to the prior art has been fully explained by the above description.

[0013] A self-piercing type rivet setting system 30 according to the present invention will now be described with reference to Fig. 2. In the present invention, the first controller is incorporated in the second controller to be formed into a single integrated controller 31. From the

integrated controller 31, a single interface cable 33 extends to a robot served as a moving means and an additional single interface cable 34 extends to a rivet feeder 9. Further, a rivet swaging assembly 35 is integrally incorporated into the robot 6 as a moving means. Although the illustrated robot 6 is of an articulated electric robot type that is commonly used in a production line of automobiles, other types of robot or jig are also available so far as they are capable of positioning the rivet swaging assembly in the predetermined site.

[0014] The rivet swaging assembly 35 comprises: a C-shaped frame 38 mounted together with an interface connector to a front end of an arm 37 of the articulated robot 6 through a coupling device 45; a die 39 mounted to one end of the C-shaped frame 38; a punch 41 mounted to other end of the C-shaped frame 38, the punch 41 opposed to the die 39 to be capable of moving into contact with/away from the die 39; and a means for movably supporting the punch 41 allowing the punch 41 to move into contact with/away from the die 39. The means for movably supporting the punch 41 comprises an electric drive motor 42 fixedly mounted on a front end of the robot arm 37 and a mechanism (not shown) coupled to the motor 42 for moving the punch 41 in a linear direction. A housing 43 containing the drive motor 42 therein is formed to extend horizontally, which is different from the one according to the prior art in which it is formed to extend vertically. Accordingly, the height of the rivet swaging assembly is advantageously reduced so that the device could move even into a narrow space. The punch moving mechanism disposed mainly in a horizontal housing 43 to move the punch 41 in a vertical direction may be composed of, for example, a lead screw mechanism arranged in the horizontal housing portion and a flexible rod to transmit a linear motion of the lead screw mechanism to the punch 41. Adjacent to the punch 41 is arranged the receiver mechanism 17 to receive a self-piercing type rivet sent from the rivet feeder 9 through the pipe 15.

[0015] An interface cable 33 is provided extending from the integrated controller 31 to the robot 6 for the purposes of, including, sending a command to the electric motor 42 to be driven, measuring a riveting pressure loading applied to the punch and a displacement thereof to determine whether or not the measured value is within a proper range, and measuring, prior to riveting, a length of a self-piercing type rivet and a thickness of a panel as a workpiece to be riveted. The integrated controller 31 has, in addition to the function of controlling the robot 6, a first additional function of controlling the electric drive motor 42 of the rivet swaging assembly 35, a second additional function of variously monitoring and determining as described above, and a third additional function of controlling the rivet feeder 9. The self-piercing type rivet setting system 30 according to the present invention not only operates similarly to the conventional self-piercing type rivet setting system 1 but also reduces the dimension or size as a whole and the number of in-

terface cables, so as to facilitate the desired positioning thereof.

[0016] As described above, since in the present invention, a rivet swaging assembly 35, a controller for the rivet feeder 9 and a controller for the robot 6 are all combined into a single integrated controller 31, neither the housing for the first controller required in the conventional apparatus nor the interface cable connecting both controllers is necessary. Since, in addition to the integration of both controllers into a single controller, the rivet swaging assembly 35 is incorporated into a moving means, the robot 6, the interface cable extending from the controller for the rivet swaging assembly to the rivet swaging assembly is no more necessary, though required in the conventional apparatus. Accordingly, the rivet swaging assembly can be placed in position desirably relative to the predetermined site to be riveted on a workpiece without interfering with complexity of the geometry of a car body or the like. Further, the present invention allows to reduce a size of a controller as a whole, a cost thereof, a size of a self-piercing type rivet setting system, and a number of cables as well.

[0017] It should be noted that since the controller for the robot has a function of controlling the electric motor as well as the robot, a function of controlling the electric drive motor of the rivet swaging assembly would be easily added thereto so that the function as the controller for the rivet swaging assembly could be simply obtained from the controller for the robot. Further, a function of controlling the articulated robot along one of axes thereof may be available for controlling the drive motor of the rivet swaging assembly. Still further, in the disclosed embodiment, the rivet swaging assembly for the self-piercing type rivet is mounted on a front end shaft of the arm 37 of the robot 37. In this case, a heavy and large electric drive motor may be mounted directly to the robot axis to reduce in size the front end portion of the robot. Alternatively, a drive motor for one of the axes of the articulated robot may be available to be used for the electric drive motor of the rivet swaging assembly, so that the coupling device 45 for coupling the integrated controller 31 with the rivet swaging assembly 35 would be unnecessary and thus, an apparatus could be reduced in size and weight, and the movement of the rivet swaging assembly would be made easier, and the interference with the workpiece to be riveted would be reduced as well.

[0018] As described above, according to the present invention, since the controller for the robot for moving the rivet swaging assembly to put it in position relative to a predetermined site on a workpiece to be riveted, or the second controller, is incorporated with another controller for the rivet swaging assembly of the self-piercing type rivet, or the first controller, to be formed into a single integrated controller, the housing for the first controller is not necessary any more and also the interface cable between the controller for the rivet swaging assembly and the another controller for the robot is not necessary, though both being necessary for the conventional appa-

ratus. Further, since, in addition to the integration of the controllers, the rivet swaging assembly is incorporated into the robot, the interface cable extending from the controller for the rivet swaging assembly to the rivet swaging assembly is no longer necessary, which is necessary for the conventional apparatus, and this reduces a possible interference with the workpiece to be riveted and ensures the riveting operation to be performed at a desired site. Thus, a size of the self-piercing type rivet setting system as a whole, a cost thereof and a size of the rivet swaging assembly could be reduced, and still further a number of interface cables could be reduced.

Claims

1. A self-piercing type rivet setting system (30) comprising:

a rivet swaging assembly (35) for setting a self-piercing type rivet, said swaging assembly comprising a C-shaped frame (38), a die (39) mounted to one end and a punch (41) mounted to other end of said C-shaped frame, a means for movably supporting said punch, said means comprising an electric drive motor (42) and a mechanism coupled with said motor for moving said punch in a linear direction;
a first controller for controlling a riveting operation of said rivet swaging assembly;
an articulated robot (6) for moving said rivet swaging assembly to put it in position relative to a predetermined site to be riveted on a workpiece;
a second controller for controlling an operation of said articulated robot; and
a rivet feeder for automatically feeding self-piercing type rivets to said rivet swaging assembly; and

wherein said first controller also controls a feeding of the self-piercing type rivet from said rivet feeder;

said self-piercing type rivet setting system **characterized in that** said first controller is incorporated into said second controller to be formed into a single integrated controller (31) and said rivet swaging assembly is integrally incorporated into said articulated robot.

2. A self-piercing type rivet setting system in accordance with claim 1, wherein said C-shaped frame (38) is mounted on a front end of an arm (37) of an articulated electric robot (6).
3. A self-piercing type rivet setting system in accordance with claim 2, wherein said electric drive motor (42) is fixedly mounted on said front end of the robot

arm(37).

4. A self-piercing type rivet setting system in accordance with anyone of the preceding claims, wherein the integrated controller (31) has the function of measuring a riveting pressure loading applied to the punch (41) and a displacement thereof to determine whether or not the measured value is within a proper range.
5. A self-piercing type rivet setting system in accordance with anyone of the preceding claims, wherein the integrated controller (31) has the function of measuring, prior to riveting, a length of a self-piercing type rivet and a thickness of a panel as a workpiece to be riveted.
6. A self-piercing type rivet setting system in accordance with anyone of the preceding claims, wherein an interface cable (33) is provided extending from the integrated controller (31) to the articulated robot (6).

Patentansprüche

1. System (30) zum Setzen von Nieten selbststanzender Art, umfassend:

eine Niet-Staucheinheit (35) zum Setzen von Nieten selbststanzender Art, wobei vorgenannte Staucheinheit einen C-förmigen Rahmen (38), einen Gegenhalter (39), der an einem Ende vorgenannten C-förmigen Rahmens montiert ist, und einen Nietstempel (41), der an dessen anderem Ende befestigt ist, ein Mittel, um vorgenannten Nietstempel auf bewegliche Weise zu halten, wobei vorgenanntes Mittel einen elektrischen Antriebsmotor (42) und einen Mechanismus umfaßt, der mit vorgenanntem Motor zum Bewegen vorgenannten Nietstempels in einer linearen Richtung gekoppelt ist;
eine erste Steuereinheit zum Steuern eines Nietvorgangs vorgenannter Niet-Staucheinheit;
einen Knickarmroboter (6) zum Bewegen vorgenannter Niet-Staucheinheit, um sie bezüglich einer vorher festgelegten Stelle zu positionieren, die an einem Werkstück zu nieten ist;
eine zweite Steuereinheit zum Steuern eines Vorgangs vorgenannten Knickarmroboters; und
einen Nietzuführer zum automatischen Zuführen von Nieten selbststanzender Art in vorgenannte Niet-Staucheinheit;

wobei vorgenannte erste Steuereinheit auch ein Zuführen der Nieten selbststanzender Art aus

vorgenanntem Nietzuführer steuert;

System zum Setzen von Nieten selbststanzender Art, **dadurch gekennzeichnet, dass** vorgenannte erste Steuereinheit zur Bildung einer einzigen integrierten Steuereinheit (31) in vorgenannte zweite Steuereinheit eingegliedert ist und vorgenannte Niet-Stauchereinheit völlig in vorgenanntem Knickarmroboter eingegliedert ist.

2. System zum Setzen von Nieten selbststanzender Art gemäß Anspruch 1, wobei vorgenannter C-förmiger Rahmen (38) an einem vorderen Ende eines Arms (37) eines elektrischen Knickarmroboters (6) montiert ist.
3. System zum Setzen von Nieten selbststanzender Art gemäß Anspruch 2, wobei vorgenannter elektrischer Antriebsmotor (42) fest an vorgenanntem vorderen Ende des Roboterarms (37) montiert ist.
4. System zum Setzen von Nieten selbststanzender Art gemäß einem der vorhergehenden Ansprüche, wobei die integrierte Steuereinheit (31) die Funktion hat, eine Nietdruckbelastung, die auf den Nietstempel (41) ausgeübt wird, und eine Abweichung davon zu messen, um festzustellen, ob sich der gemessene Wert innerhalb eines geeigneten Bereichs befindet oder nicht.
5. System zum Setzen von Nieten selbststanzender Art gemäß einem der vorhergehenden Ansprüche, wobei die integrierte Steuereinheit (31) die Funktion hat, vor dem Nieten eine Länge eines Niets selbststanzender Art und eine Stärke einer Platte als ein zu nietendes Werkstück zu messen.
6. System zum Setzen von Nieten selbststanzender Art gemäß einem der vorhergehenden Ansprüche, wobei ein Schnittstellenkabel (33) angelegt ist, das von der integrierten Steuereinheit (31) zu dem Knickarmroboter (6) verläuft.

Revendications

1. Système (30) de pose de rivets du type auto-perforant comprenant:
 - un ensemble (35) de refoulement de rivet servant à poser un rivet du type auto-perforant, ledit ensemble de refoulement comprenant un cadre en forme de C (38), une bouterolle (39) montée sur une extrémité et un poinçon (41) monté sur l'autre extrémité dudit cadre en forme de C, des moyens pour supporter d'une manière mobile ledit poinçon, lesdits moyens comprenant un moteur d'entraînement électrique (42) et un mécanisme couplé audit moteur pour

déplacer ledit poinçon dans une direction linéaire;

un premier dispositif de commande pour commander une opération de rivetage dudit ensemble de refoulement de rivet;

un robot articulé (6) pour déplacer ledit ensemble de refoulement de rivet de manière à le placer dans une position par rapport à un site prédéterminé pour être riveté sur une pièce à traiter;

un second dispositif de commande pour commander une opération dudit robot articulé; et un dispositif d'amenée de rivets pour amener automatiquement des rivets du type auto-perforant audit ensemble de refoulement de rivets; et

dans lequel ledit premier dispositif de commande commande également une amenée des rivets du type auto-perforant à partir dudit dispositif d'amenée de rivets;

ledit système de pose de rivets du type auto-perforant étant **caractérisé en ce que** ledit dispositif de commande est incorporé dans ledit second dispositif de commande pour constituer un seul dispositif de commande intégré (31) et ledit ensemble de refoulement de rivets étant intégralement incorporé dans ledit robot articulé.

2. Système de pose de rivets du type auto-perforant selon la revendication 1, dans lequel ledit cadre en forme de C (38) est monté sur une extrémité avant d'un bras (37) d'un robot électrique articulé (6).
3. Dispositif de pose de rivets du type auto-perforant selon la revendication 2, dans lequel ledit moteur d'entraînement électrique (42) est monté de façon fixe sur ladite extrémité avant du bras de robot (37).
4. Système de pose de rivets du type auto-perforant selon l'une quelconque des revendications précédentes, dans lequel le dispositif de commande intégré (31) a pour fonction de mesurer une charge de pression de rivetage appliqué au poinçon (41) et déplacement de ce dernier pour déterminer si la valeur mesurée se situe ou non dans une gamme correcte.
5. Système de pose de rivets du type auto-perforant selon l'une quelconque des revendications précédentes, dans lequel le dispositif de commande intégré (31) a pour fonction de mesurer, avant le rivetage, une longueur d'un rivet du type auto-perforant et une épaisseur d'un panneau en tant que pièce à traiter devant être rivetée.
6. Système de pose de rivets du type auto-perforant selon l'une quelconque des revendications précé-

dentés, dans lequel il est prévu un câble d'interface (33) s'étendant depuis le dispositif de commande intégré (31) jusqu'au robot articulé (6).

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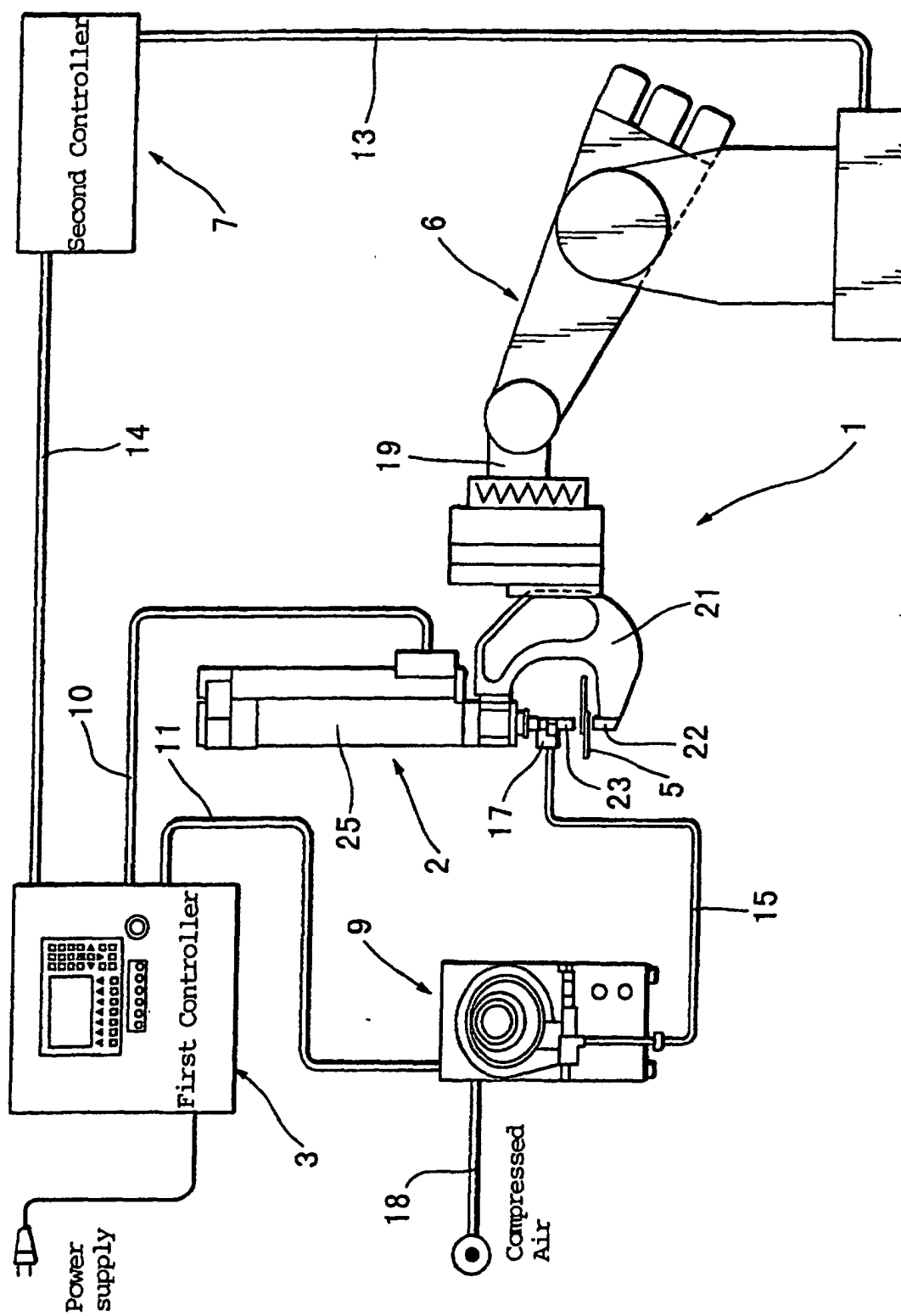


FIG. 1

