DESCRIPTION:

REFERENCES CITED :

Prior art 1: ZL200480036640.2 (CN 100522453 C), 2009. 08. 05

Prior art 2: CN 102350567 B, 2013. 07. 03

Prior art 3: US 10,843,285 B2, 2020. 11. 24

FIELD OF THE INVENTION

The invention relates to a customized jig fixture device for laser welding two free running circular tubes of the similar diameter concentrically with robotic arm auto loaders to meet the requirement of high efficiency automatic laser welding processing. addressing the specific requirements of the industrial 4.0 advanced manufacturing coving many industrial sectors. The invented apparatus has the functionality of accept the two free-running tubes from a robotic arm auto loader, to hold the two tubes concurrently with self-concentricity aligning, to let the two tubes closely meetup at the joining section (to get a good contact for the tact weld), to let the laser beam shining in for auto tact welding, to auto rotating the two tubes concurrently, to let the robotic arm auto adjusting the joining section to the seam welding position, to let the laser beam access the full circumference of the tubes to conduct the full seam welding, to let the robotic arm to automatic pick up the welded tube to unload into the pre-defined unloader tray. It can be used in the mass production machines in many industrial sectors, including aerospace industry, bio-medical industry, and general electronics industry.

BACKGROUND OF THE INVENTION

The driving objective behind the development of new automated combinations of mechanisms is to revolutionize the laser welding process, eliminating the need for human intervention and thereby mitigating safety hazards associated with traditional methods. By harnessing cutting-edge technology and innovative engineering, these automated systems aim to enhance production efficiency and quantity. By streamlining and automating the welding process, these novel systems not only minimize the risk of accidents and injuries to human operators but also optimize efficiency and productivity, ultimately leading to significant advancements in manufacturing processes across various manufacturing sectors.

In one application, it is required to make the automatic laser full seam welding process of the two free running tubes, refer to Fig 1, for example tube 1 at OD6mm and length 20mm (1), and tube 2 at OD6.2mm and length 1000mm (2), with robotic arm auto loader. As the two tubes end surface are flat and cannot be pre-attached each other, the typical manual laser welding operation of such tubes is separated into two processes. The 1st process is put the two tubes onto two concentric 3-jaw chuck clamper and push against each other to let the two end faces closely contact each other, then apply laser spot welding at two to three locations separated evenly along the circumference of the joining circle. The 2nd process is to turning the tact welded tubes for full round, or about 370 degree with some extend of overlapping for the start and ending point of the weldment to form a complete hermetic seal of the join. While the tubes are rotating, the proper laser beam is applied to the tubes joining section outline till the end of the rotating motion. Then the full seam weld on the tubes joining position along the whole circumference are generated. Then the welded tubes can be taken out from the laser welding chuck. However, this kind of manual operation is not able to be implemented with a robotic arm auto loader, as the traditional 3-jaw chuck or 4-jaw chuck only accept part loading from the hollow centre. Fig 2 illustrated a required laser welding

system for the two tubes (1) , (2) with the laser welding optical head (5) and the robotic arm loader unloader (3), tube part picker (4).

Prior arts:

In the prior art 1, ZL200480036640.2, a tube welding system is developed with robotic arm and a rail track to locate the laser beam at required location. Refer to Fig 3.

In Prior art 2, CN102350567B, developed an apparatus and harness for a tube joint internal surface welding with arc welding system. Refer to Fig 4.

In Prior art 3, US10843285B2, invented a welding device for welding a workpiece using a welding robot includes a welding control device that controls operation of the welding robot and a preheating device that preheats the workpiece. Refer to Fig 5.

However, none of the prior arts mentioned about the automatic loading unloading of the work pieces onto the welding bed for an efficient welding of two free running tubes, especially when one tube is at very short length.

TECHNICAL FIELD

At the core of this invention lies a sophisticated rotating mechanism, meticulously designed to streamline the loading/unloading and tact welding, seam welding processes without the need for human intervention as seen in many laser welding machine operation. Refer to Fig 6, The current implementation jig fixture system consists of an AC serve motor driving gear box assembly (6), open top spur gear (7). The two jaw grippers (14) are carried by the rotatory spur gear with the V-groove on the gripper concentric to the spur gear. On the gripper V groove (14B) inner side, there are flexible rubber sticks attached to the contacting lines to the work part tubes. So that when the grippers are closed by pneumatic pressure, the 4 rubber sticks (14A) contacting with the tubes to be welding. As the rubbers have the flexibility, thus the two tubes with dissimilar diameter can be clamped together without slippery. The open top spur gear and the 2-jaw gripping mechanism enables seamless loading unloading of the two tubes onto the jig fixture by robotic arm loader with ease. With the pre-arranged two

tubes holder tray, the robot arm gripper can pick up the two tubes together, and Then carry them onto the welding fixture from the top opening slot and the open grippers, then the IO communication system give signal to let the griper to close up, then the robot arm return to standby position.

Next, the laser welding head will come in and apply the tact welding at pre-defined 3 positions of the joining position. After the tact welding complete, the machine controller will send signal to robot to come in hold the tubes and push the tact welded position to the 2 jaw gripper outter side. This can let the two tubes joining section fully expose to the welding laser beam, the next, signal is giving to the AC servo motor to rotate for pre-set angle of, for example 370degree, and on the laser concurrently to perform the full round seam welding.

The work piece will be rotating at preset speed according to the laser power ad pulse repetition frequency, and protection gas to achieve the perfect finish with required penetration, when the laser seam welding is completed, the laser welding head will return to its standby position, and the robot arm is called in to pick up the welded tube from the spur gear open top slot.

In one of the implementation of an auto laser welder machine, in-line machine vision system is integrated to the laser welding head, this enables the tube end surface joining line auto alignment and the weldment auto inspection after the full seam welding before calling in robot to unload the welded tube.

DESCRIPTION OF INVENTION

The invention is a customized, compact, and precise jig fixture system facilitate the automatic laser welding processing for tubular parts with robotic arm auto loader unloader. It can be controlled by machine PC or PLC based programming system to holding the working parts, or driving the parts for certain angles or align the parts to required positions through the flexible programming of the machine controller. The design accommodates all necessary components, offering superior production capacity. Content of present implementation includes:

1. Gear Assembly Block: consists the driving mechanism required for rotation of jig
2. Rotary base with Holder: Facilitates precise rotational movements for accurate welding.
3. An AC Servo Motor: acts as the driving force for the whole setup.
4. Stop Tongue with Sliding Mechanism: Ensures controlled halting for safety and performance.
5. Limit Sensors: Enhance responsiveness and accuracy through feedback control.
6. 2-Jaw Gripper: Secures the second workpiece for stability and precision during welding.
7. Pneumatic Gripper cylinder: Controls jaw gripper open/close to hold or release the parts.
8. Laser Welding Technology: Enables precise fusion welding for structural integrity.
9. Sensor Array and Stopping Mechanism: Facilitates smooth operation and controlled stopping actions for operational integrity.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is made more apparent with reference to a preferred embodiment with the aid of the drawings. The drawing shown in:

Figure 1 Is the overall dimensions of the two sample free running tubes to be welded together.

Figure 2 Is the overall representation of Prior art Patent no. ZL200480036640.2.

Figure 3 Is the overall representation of Prior art Patent no. CN 102350567 B.

Figure 4 Is the overall representation of Prior art Patent no. US 10,843,285 B2.

Figure 5 Is the overview of Robot Auto Loader and Unloader.

Figure 6 Is the isometric view of the apparatus discussed.

Figure 7 Is the transparent view of gearbox showing the gear assembly.

Figure 8 Is the overview of 2-Jaw chuck, or pneumatic actuated 2-jaw Gripper.

Figure 9 Is the top view representation of apparatus with two tubes (17) (18) loaded, gripped.

Figure 10 Is the embodiment overview of stopping mechanism and the sensors.

Figure 11 Is the overall view after the workpieces loaded to the apparatus and ready for welding.

DETAILED DESCRIPTION OF THE INVENTION

Figure 5 represents the pick and place robotic arm (3), and robot end gripper (4) which aids in loading and unloading the both workpieces. When the work pieces loaded from the top side, the signal will be sent from the controller to actuate the gripper so that workpiece will be holded concentrically to the sectioned spur gear. Then laser beam from the aperture (5) will perform the welding process while the workpiece is in circular motion

Figure 6 illustrates the assembly of the tube welding jig, displaying its components and functions. At its core is the gear assembly block (6), providing structural support. Integrated within is the sectioned spur gear with holder base (7) for rotational movement. Driving the system is a 200W AC servo motor (8). A stop tongue with a sliding mechanism (9) and limit sensors (10) provided to halt the motion once the welding is performed

In Figure 7, a transparent view reveals the gear assembly (11) as the main driver. A sectioned spur gear (12) aids rotation, while a jaw gripper (14) secures a shorter workpiece (13). Pneumatic control (15) manages the gripper. The shorter workpiece length may range from 10mm to 50mm and the longer one ranges from 1000mm to 2000mm.

Figure 8 shows how the 2 jaw gripper is designed for the requirement. It consist of 2 jaws which operates in linear motion to the center point to actuate the grippring function of workpiece. The jaws are powered by the pneumatic force. The Jaw is designed with V shaped groove (14B) and having 2 rubber bars (14A) on each grippers, which helps in accommodating the tolerance of the work piece as our requirement states that the workpiece diameter may vary from 5.8mm to 6.2mm.

Figure 9 shows a top-down view, with a holder (11) for easy access. Workpieces (12) and (13) are positioned for welding, facilitated by laser beam. The laser beam will enter through

the window (14). the top view makes easier to understand how the system is simplified for the robotic arm to load and unload by the opening at top side.

Figure 10 details the sensor array and stopping mechanism. The procedure involves rotating the tack-welded tubes almost completely around, approximately 370 degrees, allowing for some overlap at both the beginning and end of the weld to ensure a fully sealed joint. So when the welding process is completed , tag(15) will hit the sensor and activates the limit sensor (16), ensuring precise control. The stop tongue with a slider (17) ensures smooth halting post-welding.

Figure 11 shows how the work piece are set into the sectioned spur gear (19) holding the 2 jaw gripper. When the workpieces clamped together and ready to be weld, the spur gear will rotate till the welding is completed. Then the robotic arm (20) will take out the welded part for visual inspection through the camera programmed for that purpose.

CLAIMS:

What is claimed is:

1. A motorized auto welding jig fixture device (6) for welding two free running circular tubes (1) & (2) of the similar diameter concentrically with robotic arm auto loaders/unloader (3), comprising a programming controlled motor driver, a gear box to transfer the motor rotating motion to the parts holding and rotating system spur gear and program controlled 2-jaw gripper system.

2. The jig fixture device according to claim 1, further comprising the gear box with a sets of mechanical gears (11) to transfer the rotating motion from the motor shaft to the final spur gear and gripper assembly, in the 1:1 gear ratio or an specific gear ratio according to the specific welding process requirement.

3. The jig fixture device according to claim 1, further comprising the spur gear (12) which has a hollow shaft (7) and the 2-jaw gripper fixed to the front end, with or without position aligning sensors (21) and trigger plates (20) at the other end. The spur gear have open portion at top side and link to the hollow shaft, this enables the long part to be loaded or unloaded from top to the gripper and the gear box using the robot arm or other handler, or even human hand when doing some manual testing.

4. The jig fixture device according to claim 1, further comprising the pneumatic or electrical operated 2-jaw grippers (14) with V-grooves or similar self-centering mechanical mechanism to auto align the loaded tubes to be concentric to the hollow shaft spur gear.

5. The gripper V-groove (14B) or similar self-centering mechanical mechanism according to claim 4, further comprising the rubber bar (14A) or similar spring loading device at the 4 sides of the grooves side wall, like a spring plunger, to overcome the two tubes diameter difference to be clamped together within the one common gripper.

6. The gripper V-groove or similar self-cantering mechanical mechanism according to claim 4, further comprising the tact-welding holes at the grippers left (14B), right (14A), and / or top side (19) to enable the welding beam to be come in and reach the joining portion of the two tubes gripped.