International Journal of Engineering Research and General Science Volume 2, Issue 1, January 2014
ISSN 2091-2730

A Review on Material Handling & Clamping System for wear plate welding machine

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Abstract- Wear plate welding machines requires some special raw material handling system as they are heavy to handle.Wear plate welding requires 4-5 workers for handling and clamping of raw material. This paper reviews different material handling equipment used by various industries. As the raw material is heavy, it is very difficult to handle manually. Hence there is requirement of integrated material handling and clamping system to do this heavy task. An integrated approach for material handling and clamping is suggested.

In this paper, various handling mechanisms like scissor lifting mechanism, hydraulic lift platform in scissors type mechanism, hydraulic lifting system based on multistage telescopic cylinder are discussed. Their analysis is done by using various software. Some failure diagnosis points are also discussed by mathematical calculations. Clamping mechanisms like electric power clamping device driven by step motor and screw-toggle-lever force amplifier in series, unilateral fixtures for sheet-metal parts with holes are discussed.
Keywords— Material handling systems, clamping system, mechanisms, analysis, CAD, CAE,wear plate welding machine.

INTRODUCTION

Wear plate welding machines are generally used for depositing material on the metal sheets. This causes increase in the life of the wear plate. These wear plates can be used for making boilers, cement plants, containers, etc. There is no standard provided for building this machine. It consist of one moving bed, welding guns, platform moving welding gun in x-direction. The bed with wheels is allowed to move in y-direction. The welding guns are used to deposit material on the surface of the wear plate in order to improve its life period.

Figure 1 shows the generalize structure of wear plate welding machine.

Fig 1: Wear plate welding machine[9]

In some industries weight of wear plate is always above 100kgs. Handling of wear plates in industry is big task. As the wear plate weight is high, more than one man gets involved for handling metal plates. These machines are local made machines so there is no such arrangement provided for handling the metal sheets. Most of the companies use crane system for lifting these plates.

Clamping of the wear plate in most of industries is done manually. They use C-clamps, L-clamps, nut and bolts for clamping. Even though the clamps are used, some packing materials always require for filling gap between clamps and wear plate surface. The size of the bed is fixed but the size of wear plate always varies. For the sizes less than the bed, there is always need of some temporary welding for fixing the clamps. These welded clamps are removed when the welding is over. For this one welder is always needed for every single cycle of welding.

So, this is very tedious work and takes nearly one hour for loading and unloading of these heavy wear plates. So, there is scope of automation up to certain extent.

BACKGROUND OF IDEAS

For designing a system for material handling and clamping, work is divided into two parts.1) Study of Handling mechanisms.2) Study of clamping devices and systems. Handling mechanism consists of loading of raw material and unloading of finished product. All the parameters like weight of raw material, size, etc are to be considered while studying.

A) MATERIAL HANDLING MECHANISMS

Various material handling equipment ideas are suggested by experts. These mechanisms can be considered while developing handling mechanism. First one is optimal design of Scissor Lifting Mechanism [5]. In this paper, a mathematical model is established for the research on scissor elevator by Tao Liu and Jian Sun. The kinematical and kinetic simulation analysis was carried out with MATLAB/Simulink. 3-D modeling of scissor lifting mechanism was developed. Pro/E software is used for modeling. The author suggested that the design was scientific and reasonable. It can be ideal document for one who is interested in modeling design of scissor lifting mechanism. Figure 2 shows scissor lifting mechanism.

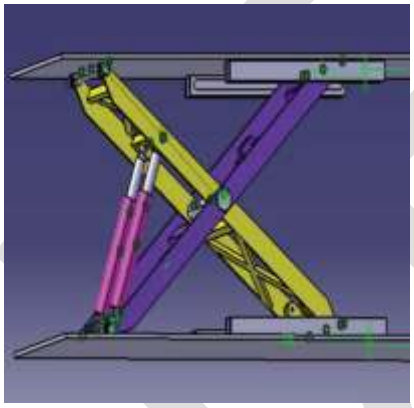

Fig 2: Scissor lifting mechanism [5]

Design and Simulation Based on Pro/E for a Hydraulic Lift Platform in Scissors Type is carried out by Tian Hongyu and Zhang Ziyi [4]. CAD software is used for modeling scissors lift platform. For the height of 8m the modeling is done. For that Pro/E software is used. This technique makes the possibility of assemble and the using performance analyses in front of manufacture. Figure 3 shows design of lift platform model.

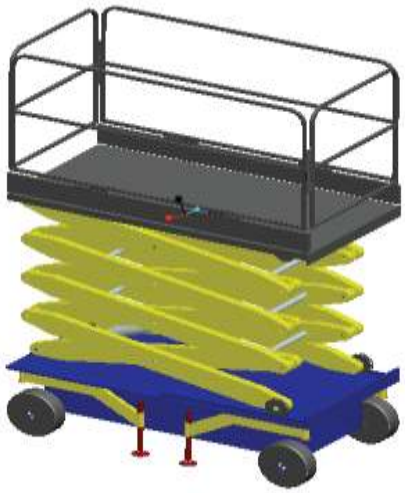

Fig 3: Lift platform model [4]

Taoping Yan [1] presented Analysis and Design on Air Controlled Hydraulic System about Dump Truck Lifting Mechanisms. In this paper, a lifting mechanism of hydraulic control system is discussed. By calculating the main technical parameters like control of power take, distance of lift , carriages stop, upward and downward motion of platform, lifting mechanism can be developed. The lifting mechanism has a hydraulic system of air control equipment, and other different characteristics. So while designing one should take into account for all these factors.

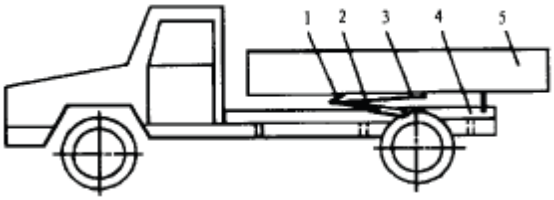

Fig 4: 3201Z-type lifting mechanisms [1]

As shown in figure 4, the air controlled hydraulic lifting mechanism used by 3201Z-type dump truck consists of the carriage (5), the Deputy Frame (4), lever (1, 3) and the lifting tanks (2).

Yang Miao and Shaoping Wang [2] presented Failure Diagnosis of Hydraulic Lifting System Based on Multistage Telescopic Cylinder. Failure modules and collaborative failure simulation platform for hydraulic lifting system based on multistage telescopic cylinder is discussed. This paper can simulate the detailed failure mode and its performance. It can also provide the design modification. The main factor for the design process is inappropriate bearing surface between two stages of multistage telescopic cylinder. Also proper alignment should be considered. The simulation results can suggest the nature of failure of multistage telescopic cylinder. Thus, fault diagnosis for lifting system can be done.

Sheet and pallet lifters can also be used for material handling. Various pallet lifters like sheet lifter with pin-on angle extensions, sheet lifter with adjustable position lifting feet and many more special purpose pallet lifters are also best for material handling. One of the examples is as shown in figure 5.

Fig 5: Pallet Lifter[10]

Up to this various material handling equipments are discussed. This can be helpful for designing handling system. Next step is study of clamping devices.

B) CLAMPING DEVICES AND MECHANISMS

As clamping on wear plate welding machine is challenging task, there are various mechanisms suggested by experts. Sun Chengfeng & Zhong Kangmin [3] suggested the electric power clamping device driven by step motor and screw-toggle-lever force amplifier in series. Its working principle is, the rotary motion of the step motor is changed into linear motion of the clamping component. It can always be maintained the clamping force acting on the work piece during manufacturing process. Figure 6 bellow shows the working principle of basic device.

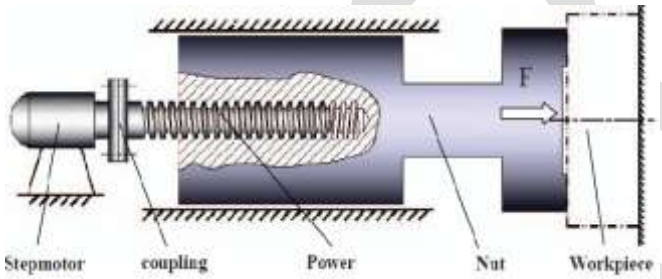

Fig 6: The working principal of basic device [3]

On the basis of above structure, there are four types of clamping derived which can be used for clamping as per requirement. These are as follows.

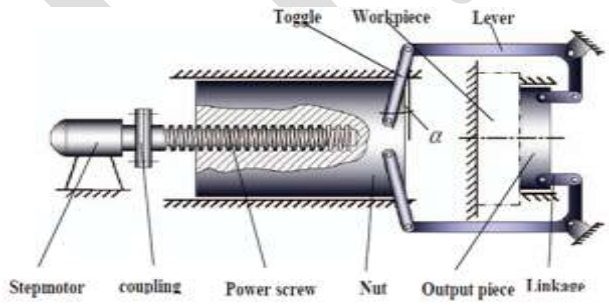

Fig 7: The one way inner clamp device [3]

Above figure 7 shows inner clamping device arrangement. It can be useful when clamping should be on inner side.

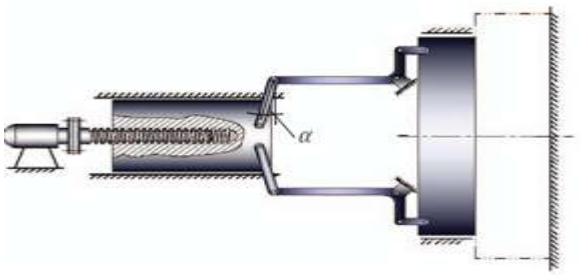

Fig 8: The one way outside clamping device [3]

After that, figure 8 showing outer clamping device is displayed. It can be useful when clamping should be from one side of work piece and from outside.

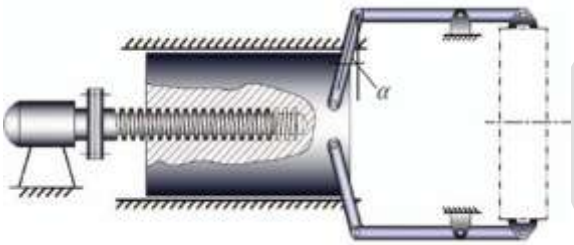

Fig 9: Bidirectional inner clamp device [3]

Bidirectional inner clamping device arrangement is shown in above fig 9. It is useful when inside clamping is required from both the sides of work piece.

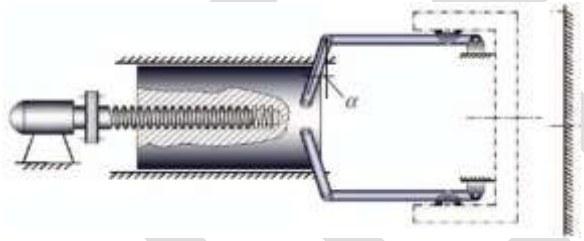

Fig 10: Bidirectional outer clamp device [3]

Lastly, bidirectional outer clamp arrangement as in above. It can be useful when clamping is required in both directional and from outside.

Detailed working of the four types of fixtures are discussed in the paper. These types of electrically operated clamps are useful as they are pollution free.

Cai-Hua Xiong, Michael Yu Wang, and You-Lun Xiong [7] suggested on clamping planning in work piece-fixture systems. In this paper a method for determining the optimal clamping forces is suggested. Also its magnitudes and positions can be suggested. A set of equations are derived. These equations are used to describe the relationship between the displacement of the work piece and the deformations at contacts. Further, a locally elastic contact model to characterize the nonlinear coupling between the contact force and elastic deformation at the individual contact is developed. It gives the minimum norm of the elastic deformations at contacts as the objective function, then suggested optimal clamping forces which guarantees that the fixturing of the work piece is force closure.

Gopalakrishnan K., Ken Goldberg,, Gary M. Bone, Matthew J. Zaluzec[8] presented unilateral fixtures for sheet-metal parts with holes. This paper introduces new way of holding sheet-metal with holes. A pairs of grooved cylinders, from only one side of the part is used for fixture. The cylinders mates with opposite corners of holes in the part. Also they are push apart to hold the sheet in

tension. It has both locators and clamps. It gives technical calculations for a unilateral fixture to hold a given part. An algorithm is specified for selecting unilateral fixtures automatically.

Jialiang Zhang, Jianguo Yang, Beizhi Li [6] suggested new type welding fixtures. It is reconfigurable. The parts having same type of features can be mounted on this fixture. Main advantage of this fixture is that, even if the dimensions of the features in the part changes, fixture is ready to adapt as per the dimensions. It consist of platform with number of holes in X and Y directions, supporting columns, locators and pneumatic control system. Software used for designing the fixture is UG. Analysis for displacement, stiffness, interference is done by using ANSYS and ADAMS. The modular mechanism is as in fig 11. bellow.

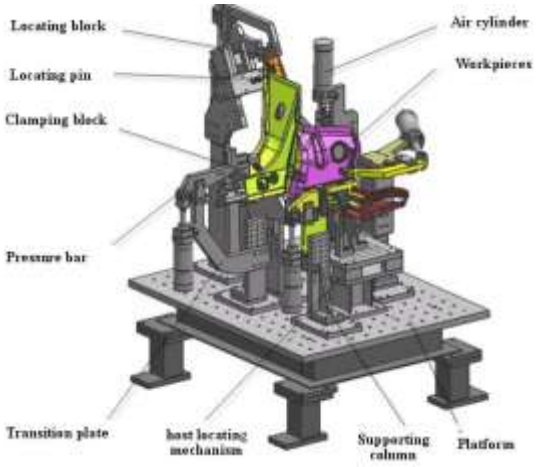

Fig 11: Modular Mechanism [6]

CONCLUSION

It is seen that by using various handling mechanisms, as per the conditions it can be helpful for welding process. As the wear plates are heavy, safety is all time priority. Clamping systems plays an important role during welding. By using such types of techniques which are discussed, it will lead to reduction in cycle time required for loading and unloading of part which is nearly one hour. Also automation provides less use of human efforts and indirectly leads to the safety of the operator.

Some concepts like electric power clamping device driven by step motor and screw-toggle-lever force amplifier in series, unilateral fixtures for sheet-metal parts with holes suggest new approach in their field. Significant improvement can be assured if modern CAE, CAD and computational techniques are used in designing the systems.

Summary of previous work done.

SR. NO	TITLE OF PAPER	NAME OF AUTHOR	NAME OF JOURNAL	PURPOSE OF WORK	REMARK
1)	Analysis and design on air controlled hydraulic system about dump truck lifting mechanisms	Taoping Yan	IEEE 2011	A lifting mechanism of hydraulic control system is discussed and suggested procedure for calculating it`s technical parameters.	Technical parameters like control of power take, distance of lift , carriages stop, motion of platform are calculated mathematically

2)	Failure diagnosis of hydraulic lifting system based on multistage telescopic cylinder	Yang miao and Shaoping wang	IEEE 2011	For analysis of hydraulic lifting system based on multistage telescopic cylinder, various possibilities of failures discussed.	Failure analysis of MTC is done with factors like hydraulic power supply, damage of bearing surfaces, wear and tear of piston, leakage, creeping & jam.
3)	Simulative calculation & optimal design of scissor lifting mechanism	TaoLiu, Jian Sun	IEEE, 2009	The kinematical and kinetic simulation analysis of scissor lifting mechanism for automobiles at high altitude work was carried out	Simulation analysis is done by using MATLAB/Simulink. Modeling is done by using Pro E.
4)	Design and Simulation Based on Pro/E for a Hydraulic Lift Platform in Scissors Type	Tian Hongyu, Zhang Ziyi	Elsevier Ltd. 2010	A design based 3D software Pro/E with 8m high scissors lift platform, which gives a entire platform dimension with 1800 × 900mm2.	Pro/E software is used for modeling lift platform for material handling.
5)	The Electric Power Clamping Device Driven by Stepmotor and Screw-Togge-Lever Force Amplifier in Series	Sun Chengfeng & Zhong Kangmin	IEEE 2011	A new type of electrical power clamping device is developed and its 4 basic models are suggested for clamping.	Four different clamping devices can be used as per requirement. The rotary motion of the step motor is converted into linear motion of the clamping component.
6)	On Clamping Planning in Workpiece-Fixture Systems	Cai-Hua Xiong, Michael Yu Wang, and You-Lun Xiong	IEEE, 2008	A general method for determining the optimal clamping forces including their magnitudes and positions is suggested.	It will help to calculate different clamping forces. Also it will help to find magnitude and position of clamping forces mathematically.
7)	Unilateral Fixtures for Sheet-Metal Parts With Holes	Gopalakrishnan K., Ken Goldberg,, Gary M. Bone, Matthew J. Zaluzec	IEEE, 2004	A new approach using pairs of grooved cylinders, activated from only one side of the part (hence “unilateral”).	Mathematically characterized the mechanics and conditions for a unilateral fixture to hold a given part. But it is not yet tested in CAD system

8)	Development of a Reconfigurable Welding Fixture System for automotive body.	Jialiang Zhang, Jianguo Yang, Beizhi LI.	ASME, 2009	Reconfigurable welding fixtures is designed for work pieces having same features but different dimension.	Modeling of fixture is done by UG software.For analysis of displacement and interference ANSYS and ADAMS are used.

REFERENCES:

1] Taoping Yan, "Analysis and Design on Air Controlled Hydraulic System about Dump Truck Lifting Mechanisms", IEEE 978-1-4577-0536-6/11, 2011.

2] Yang Miao and Shaoping Wang, "Failure Diagnosis of Hydraulic Lifting System Based on Multistage Telescopic Cylinder" ,IEEE 978-1-4244-8452-2/11 ,2011 .

3] Sun Chengfeng & Zhong Kangmin ,"The Electric Power Clamping Device Driven by Stepmotor and Screw-Togge-Lever Force Amplifier in Series", IEEE 978-1-61284-459-6/11, 2011.

4] Tian Hongyu, Beijing Union UniversityZhang Ziyi, Beijing Chaowai baijiazhuang, Beijing 100020, China, 'Design and Simulation Based on Pro/E for a Hydraulic Lift

Platform in Scissors Type', 1877-7058 Published by Elsevier Ltd. doi: 10.1016/j.proeng.2011.08.1153, 2011

5] Tao Liu1, Jian Sun2, 1. School of Automobile Engineering, Harbin Institute of Technology, Weihai, 264209, China E-mail: liutao@hitwh.edu.cn 2. Department of technology, Weihai Chemical Machinery Co., Ltd., Weihai, 264203, China, 'Simulative calculation and optimal design of scissor lifting mechanism', IEEE,978-1-4244-2723-9/09/, 2009.

6] Jialiang Zhang, Jianguo Yang, Beizhi Li, 'Development of a Reconfigurable Welding Fixture

System for Automotive Body', ASME/IFToMM International Conference on Reconfigurable Mechanisms and Robots, 2009.

7] Cai-Hua Xiong, Michael Yu Wang, and You-Lun Xiong "On Clamping Planning in Workpiece-Fixture Systems" , IEEE 1545-5955 ,2008.

8] Gopalakrishnan K., Ken Goldberg,, Gary M. Bone, Matthew J. Zaluzec, "Unilateral Fixtures for Sheet-Metal Parts With Holes" ,IEEE ,1545-5955/04, 2004.

9]http://www.seekpart.com/company/160280/products/20135171765732100.html.

10]http://www.bushman.com/index.php/content/below_the_hook/sheet_and_plate_lifters.