THE ANNALS OF " DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE XIV MECHANICAL ENGINEERING, ISSN 1224-5615
2002

ROBOT TYPE MANIPULATOR FOR SERVING OF A BOLTS HARDENING SYSTEM OUTLINE

Conf. dr. ing. Aurel CIUREA
Conf. dr. ing. Dorin EFTIMIE
Universitatea "Dunarea de Jos" din Galati
ing. Gheorghe CIURDARIU
S.C.PROMEX S.A.-Braila

ABSTRACT

The paper work refers to a flexible manufacturing cell where the bolts hardening system within a relatively wide range of dimensions is completely automatic. For this purpose, a robot type manipulator serving an induction hardening system is used.

The manufacturing cell consists of:

- *a warehouse where the bolts to be hardened are located on a slightly inclined plane, so that the bolts to successively come by rolling to the place where the are taken over by manipulator.*
- *a robot type manipulator for handling the parts from the warehouse for bolts to be hardened, on the hardening system and further into the hardened parts container.*
- *an induction hardening system for axles or bolts.*

1. System description

Robot type manipulator is designed to work within rectangular coordinates, and it may be seen in fig. 1

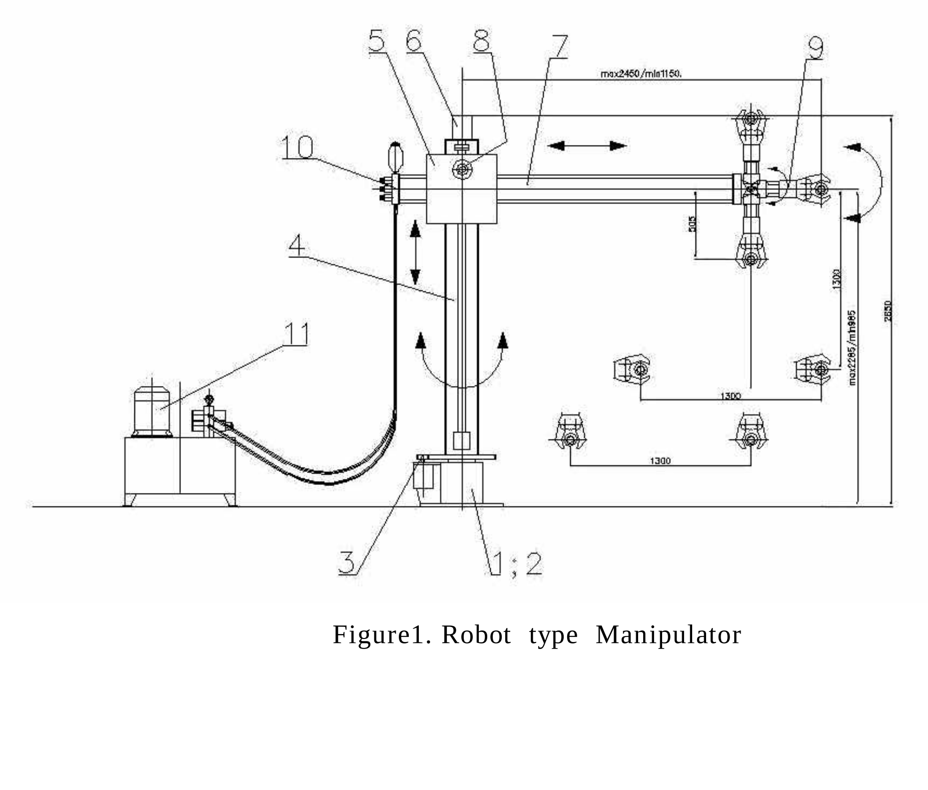


Figure1. Robot type Manipulator

It consists of support 1 where a pivot 2 is mounted by means of a bearing, being able to rotate around a vertical axis, with the help of a motor and a pinion - gear rim 3 gearing.
Rotation angle is + 150 (namely, 300 total)
The support serves for robot fixing on ground floor. A vertical column 4 of welded box shape is fastened to the pivot.
A car 5 may vertically along it which guide on vertical column with a minimum clearance.
The car movement is done through a screw-nut-rotating motor 6 mechanism. An arm 7 can horizontally travel on the car through a motor-pinion-rack mechanism 8.A guiding module 9 with two degrees of freedom, having a jaw type catching device, is fitted at one end of the arm. The guiding module-patent 99.273/14.08.1989.

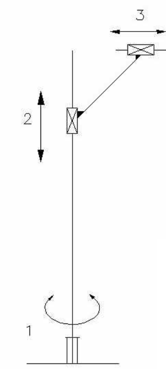


Figure 2 – Skeleton diagram for robot type manipulator

An electro hydraulic control unit 10 for guiding module is fitted at the apposite end of the arm. The skeleton diagram of the robot is shown in fig.2
The number of degrees of freedom may come out of fig.2.
where: C = (1 - 6) cinematic coupling

M=N-1; where
n=number of elements=7
C=6 cinematic coupling
Result M=7-1=6

All robot's movements are electro hydraulically driven by rotating hydraulic motors for pivot rotation, vertical movement and horizontal movement of the arm. Linear hydraulic motors (hydraulic cylinders type) are used for guiding module driving. These motors are supplied from a hydraulic power pack through some electro hydraulic manifolds.
The hydraulic driving diagram is shown in fig. 3.a.
where: MH1=column stewing hydraulic motor
MH2=hydraulic motor for arm vertical movement
MH3=hydraulic motor for arm horizontal movement
ML1=linear motor for guide unit tilting
ML2=linear motor for unit slewing
ML3=linear motor for grip gear drive
D1-D6=electro hydraulic manifolds
ApH= pneumohydraulic battery
Sl= pressure limiting valve
M=pressure gauge
P=oil pump
ME=variable speed electric motor
FU=oil filter
T=tank (oil tank)

It can be seen that the pump, providing the oil flow and pressure necessary for driving, is driven by an electric motor with variable speed. This is useful to stop the movements. When stop of a movement is controlled, the electric motor reduces its speed gradual, reducing also the oil flow and this way the movement is gradually slowed down then it is stopped from manifolds.

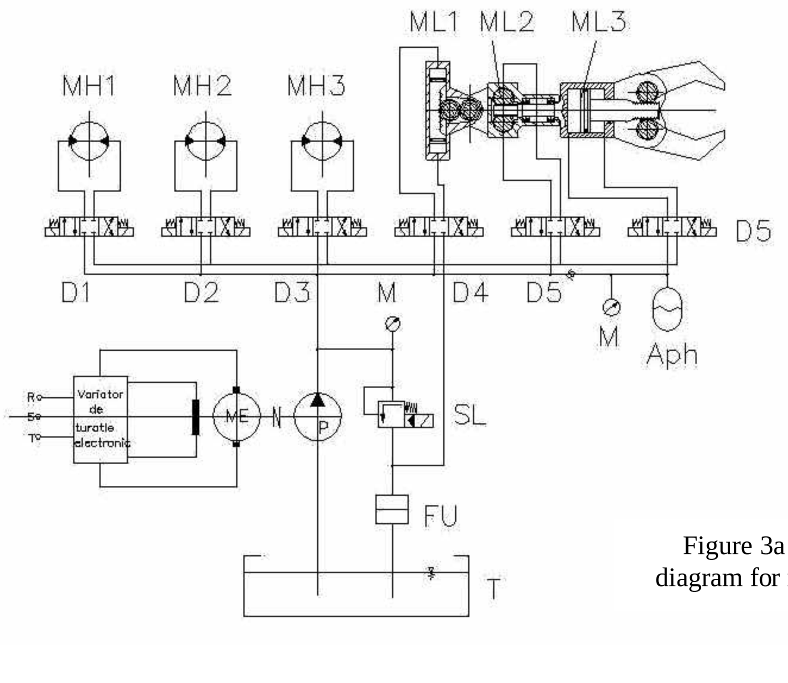


Figure 3a – Hydraulic basic diagram for manipulator driving.

Thus, the stopping shocks are eliminated and accuracy for positioning increases. For movements measurement in view of their programming and stopping in various preset points, the robot can have linear respectively rotating inductive position transducers "inductosyn " type.

Movements programming, their sequence, synchronizing and interconditioning with hardening system' s functions are provided by a numerical controlled equipment including also a computer.

A However, positioning accuracy of the part cannot be too high with such type of drive, because an exact feed-back loop between hydraulic motors and position transducers does not exist. The drive was designed to the level of eighty' s.

Considering the progress of the last years a newer version was designed, having electric drive with special motors for robots and better parameters.

2. Version for the future

In assembly, the robot is electro hydraulically driven. For rotating the vertical column, vertical movement of the car and horizontal movement of the arm, DC electric actuators of Electrotehnica S.A. Bucuresti type are used. These engines are equipped with: tacho-generator for speed control, contact less bipolar resolver, eventually incremental transducer.

These engines are electric power supplied. Rotor voltage (speed adjustment) is done by VAMZ type speed variation. The guiding module is hydraulically controlled by means of electro hydraulic control unit. This unit is supplied with under pressure oil from a small pumping unit consisting of oil tank, electro pump, safety valve and oil filter.

Where: It can be noticed that MH1-MH3, motors are missing being replaced by electric motors.

Notations are same as to fig. 3. a.

According to diagram of fig. 3.b.the guiding module movements are:

- vertical tilting ± 90
- catching device rotation by + 90
- closing (part' s catching) and opening (part' s release) of the catching device .

The three movements are done by means of three liniar hydraulic motors (hydraulic cylinder type) that are driven from the control unit.

Programming of movements, their sequence, synchronizing and interconditioning with hardening system functions are provided by a numerical controlled equipment also including a computer fig.4

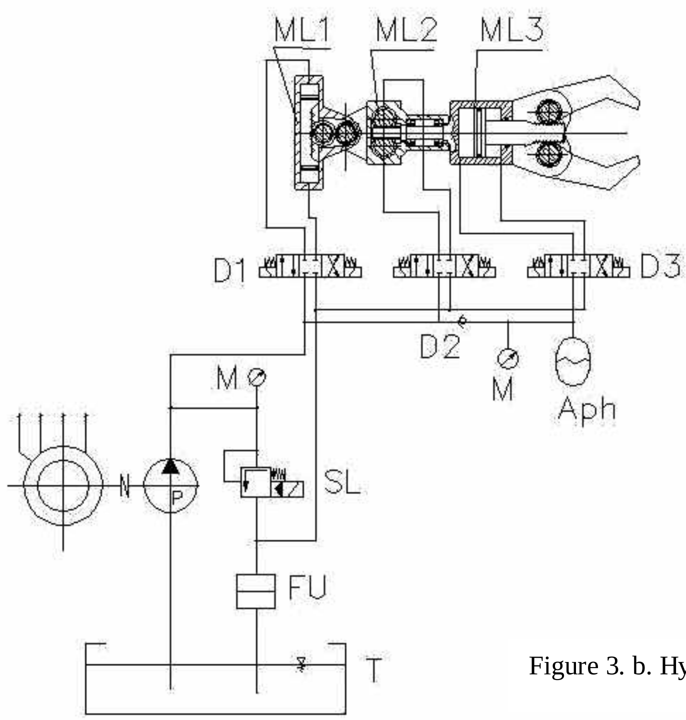


Figure 3. b. Hydraulic basic diagram.

B. Positioning is more precise than version 1.

where: 1 = induction hardening machine

2 = robot type manipulator

3 = hydraulic unit

4 = electric system for control, programming, driving.

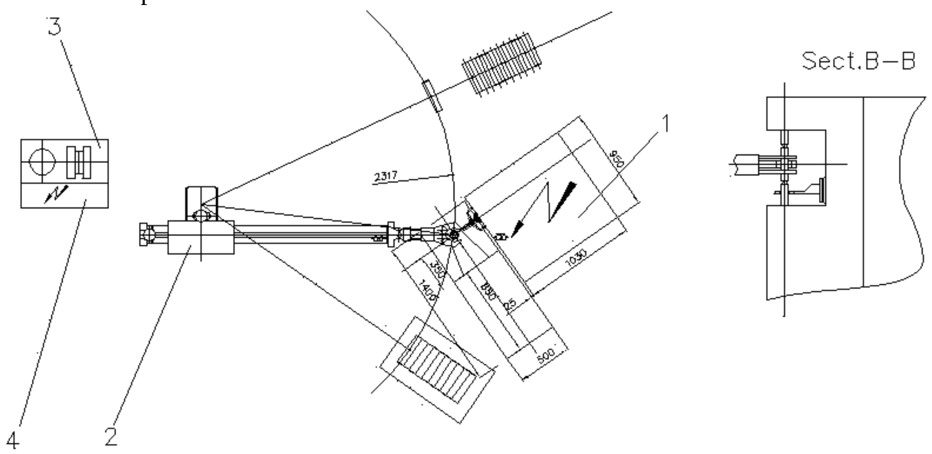
The operation mode of the robot within the flexible manufacturing cell may be extracted from fig. 4

To catch the part from the warehouse the robot rotates around vertical axis until catching device reaches the direction of the part to be processed.

The catching device opens and the arm goes forward until it reaches the part.

Part catching (automatic), arm lifting up to the level of hardening system, 90 rotation of the guiding module (so, the part), part positioning on the hardening system, part release (after it was taken over by the system), arm retreat, 90 module rotation and part release into the hardened parts container, arm rotation up to the way of warehouse are controlled and the cycle repeats.

C. Hardening system should be also adapted so that to be interconditioned with manipulator. Robot's movement should synchronize with the controls to be given to hardening machine, in view of running a complete hardening cycle, continuous repeatable cycle.



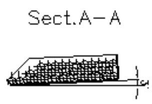


Figure 4. Example of one flexible manufacturing cell organization, for bolts induction hardering.

3. Conclusions

The efficiency of placing one robot on the manufacturing line results from the following considerations:

a) surface hardening system productivity increases by ~ 30 %, eliminating the existing pause times in working with operator.

b) flux constancy, considering that the robot shall feed to the same parameters eliminating inconstancy factors of the operator.

c) decrease of existing number of staff on manufacturing line.

d) the possibility of automatic managing of production line is created.

e) mounting such a manufacturing cell becomes extremely reliable when hardening a very big quantity of bolts.

References

[1] Francisc Kovacs, George Cojocaru " *Manipulators, robots and their industrial applications* "

[2] D.F. Lazaroiu, S. Sloiher " *Inductosyn type analogic position inductive transducers* " , Technical Publishing House, Bucuresti, 1979

[3] *Brevet 99.273/14.08.1989*

[4] *Upgrading of blanks feeding technologies for presses in home products industry - Project IPIV.No. 602/IV/1980*

[5] Richard P.J. Les Robots - *Presses Universitaires de France Paris 1979*

[6] *Industrial robots, information and documentation in machinery building No. 7 of 1978*

[7] Capcaru G - *A systematic approach of flexible fabrication process design with industrial robots 1978*