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Design & Development of Boring Operation Inspection System in the Automotive Industry

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ABSTRACT

The system presents interlock system for motor cycle frame production line to achieve the comprehensive management and control of the production process of the frame. Currently, the competitiveness of organisations is shifting to a full range of competitive products, quality, cost, and services. Simultaneously, production is gradually shifting to an automated, systematic mode. The fast, accurate transfer of information within the organization becomes particularly important.It is critical to collect and deliver information timely and accurately throughout the manufacturing process in order to manufacture products that meet customer requirements while also being efficient enough to meet market demand. The system uses the PLC-Programming to activate and de-activate the sensor. In additional technology is to provide greater flexibility, fluidity, eliminating the cost and effort spent on to handle the frame.in this system the fatigue of the labour are decreases and also the chances of unbored component is supplying the customer is reduced.

Keywords:Keywords: Interlock system, Production Process, Automation, PLC-Programming.

Intruduction

Metal man Auto (P) Ltd. is engaged into manufacturing of Sheet Metal and Tubular Fabricated Assemblies and Sub Assemblies with In House Surface Treatment facilities such as Ni-Cr Plating , Catachresis Electrolysis Deposition (CED Painting) , Epoxy Powder Coating & Phosphate. We act as a one stop shop for all your fabrication needs and are currently catering to Global Automotive OEM's, Heavy Fabrication & Construction Equipment Industry, Off Road Vehicles & White Goods Industry. All our plants are ISO-TS 16949:2009 Certified which means supplying Defect Free Parts at a Competitive Price and at Right Time.

Metal man Team consists of over 250+ Engineers who ensure that we always meet the highest standards of Quality. Our R&D Department is capable to meet all design and prototyping demands of our customers within a stipulated time with the support of our In House Tool Room having state of the art Machinery to Manufacture all types of Too Jigs, Fixtures and gauges suited to our products.

The system presents an interlock system for motor cycle frame production lines in order to achieve comprehensive management and control of the frame production process. Organizational competitiveness is currently shifting to a full range of competitive products, quality, cost, and services. Concurrently, production is gradually transitioning to an automated, systematic mode. The quick and accurate transfer of information within the organisation becomes critical. It is critical to collect and deliver information in a timely and accurate manner throughout the manufacturing process in order to produce products that meet customer requirements while remaining efficient enough to meet mark requirements. To activate and deactivate the sensor, the system employs PLC programming. Additional technology is being developed to provide greater flexibility and fluidity, as well as to eliminate the cost and effort associated with handling the frame. The fatigue of the labour is reduced in this system, as are the chances of supplying the customer with an unbored component.

Vision Sensor have been widely used over a period of time for observation and surveillance. Vision Sensor are the combination of different sensors built on a tiny embedded device for specific observation such as temperature, humidity, pressure, motion etc. of region. a unique method for customizable design and implementation of `vision Image Sensor' for surveillance and monitoring purpose.

In the present work an attempt is made to select the combination of optimum inspection parameter which will result in better quality of fine boring of head pipe. Boring with optimal inspection parameters will result in accurate measurement and hence there is no rejection of frames.

Marking systems are frequently integrated into testing or manufacturing fixtures. A flywheel, for example, is mounted on an engine with multiple bolts that are then tightened simultaneously. When all of the bolts have been torqued to specification, the marking device moves into position and

applies a dot to confirm that the operation was performed correctly. If the dot is missing, downstream operators will be alerted that additional inspection or corrective action is required.
Parts are also frequently marked with color to facilitate assembly processes. For example, before mounting rims and tyres, assemblers may place a dot of stain on brake callipers to confirm that pads have been installed. Alternatively, a shaft could be labelled to indicate which end to insert.

2.0. Identification of problem:

METALMAN Auto manufactures the motorcycle frame. The last operation of the fabrication of the frame is Boring Operation. One manpower is deputed to mount the frame on the machine and again to remove bored component from the machine when boring is completed and hang on the conveyer. But sometime the unbored frame is hinged on the conveyer.

2.1 Current process with problem :

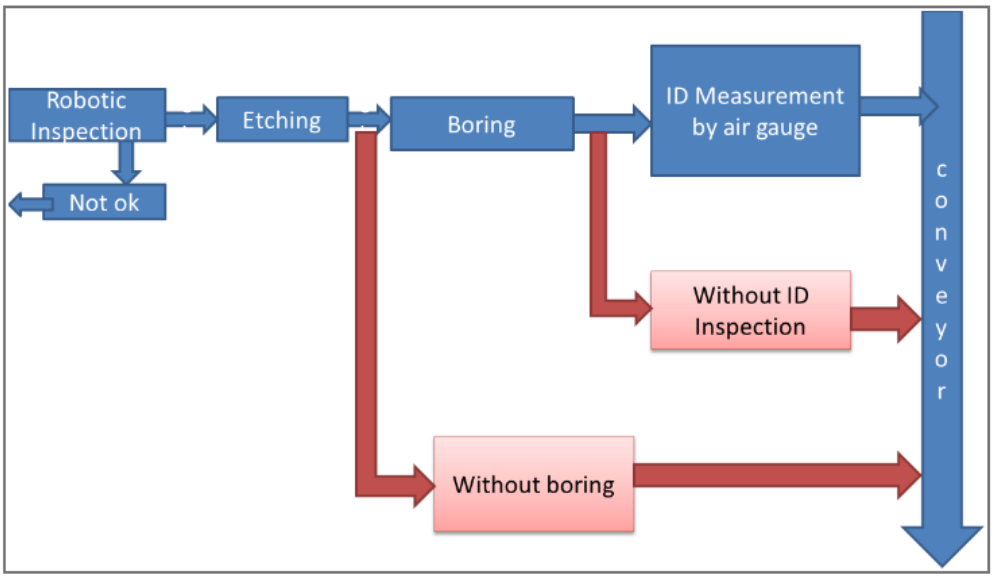


Fig : 1 Current process

1. As we know the frame is manufactured by joining 34 child parts by Co2 welding by using Robots.
2. After all frame is ready then Robotic inspection are done with the help of the laser sensor.
3. The sensor inspect whether the child part is present at right place and at equal quantity
4. If the part is not present at proper position or the part is missing then frame is send back to intial stage.
5. If frame is OK in the inspection then Etching are done with the help of pneumatic Etching machine.
6. In this Process the Batch number, Date, and Frame no is printed.
7. Then Frame moved forward towards the fine Boring Operation.
8. Accuracy of the boring required between 0.025 microns.
9. After boring operation on the head pipe , inspection of the internal diameter is done with the help of the Air gauges and the reading are displayed on the display device.
10. If the boring is within the limits as per specification then the operator makes mark of his name on the frame with the help of portable etching machine.
11. And lastly frame is Hinge on the conveyor.

2.2 Industry requirement :

1. The system should not affect the finish good
2. The unbored component cannot supply to the customers.
3. To make an automation for this problem
4. Due to this system does not increasing the machining time of the boring machine
5. The bored component should be easily identified to the worker

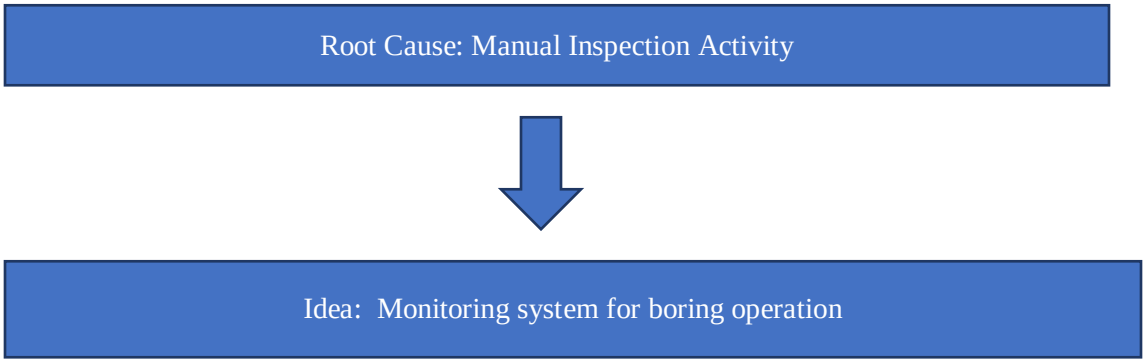
2.3 Why – Why analysis for this Problem :

1) why the customer complaints are increasing related to boring operation.

2) Ans- Unbored frame supplied to customer.

3) Why the unbored frame supplied to customer.

4) Ans-1) Interlock is not provided
2) Improper inspection system.
3)Manual fatigue



3.0 Implementation of precision measurement and vision sensor

To interlock process after robotic inspection to avoid missing of boring operation

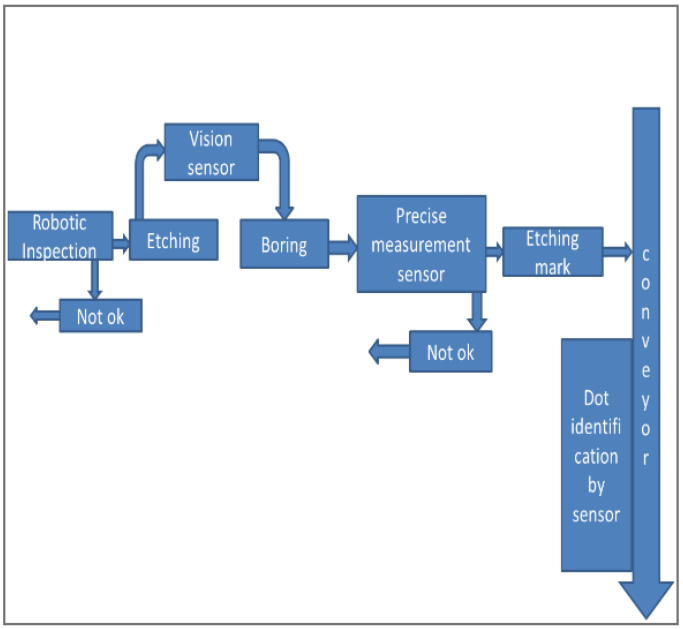


Fig 2: Proposed idea flow diagram

Praposed idea :

- After etching process, the Etching (presence/absence) is sensed by the sensor and then only the boring process will start otherwise the boring cycle will not start.
- After boring, Internal Diameter is check by the precise Measurement sensor with accuracy of 3 um. If measurement is within limits then and then only the Mark will etch by etching machine and frame is hinged on conveyor.
- Again the same mark will be check by the sensor on the conveyor , if the mark is not present on the frame then we can easily conclude that frame is not ok for dispatch.

3.1 Product List

Item description	Product code	Quantity
Controller	**LJ-V7001**	**1**
Sensor head	**LJ-V7060**	**1**
Head connection cable	**CB-B10**	**1**
Software	**LJ-H3**	**1**
Input output cable	**51657**	**1**

3.2 Vision sensor

1. It is difficult to perform complete inspections when checking items visually.
2. Specialized knowledge is required in order to select, install, and set sensors.
3. Conventional vision sensors require experience and take time to get used to.
4. Accurate detections without variations are possible
5. The entire surface is checked, providing high resistance to misaligned targets.
6. Clear images with no distortion can be captured.

Fig 3.0 vision sensor

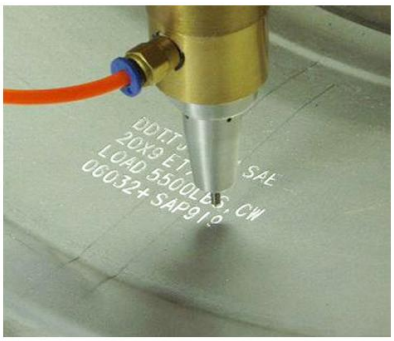
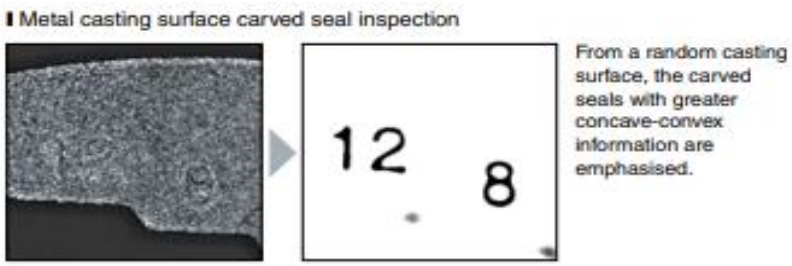


Fig 4 : Etching on the frame

3.3 Working Of the vision sensor :



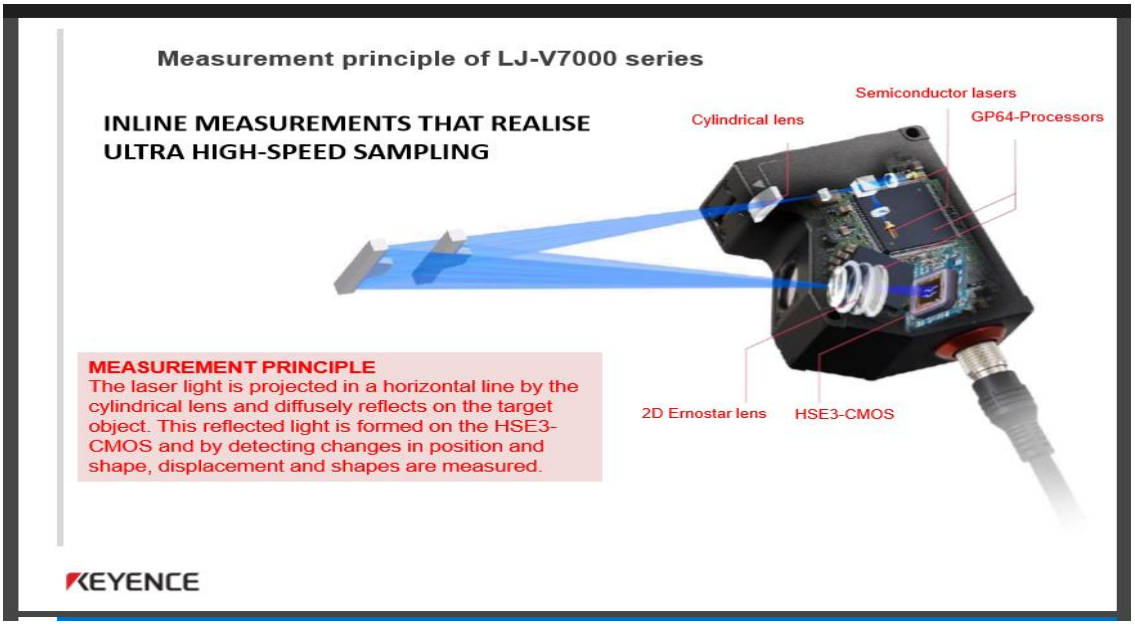
This sensor actually works on image recognition system.The images captured by the vision camera is compared with initially feed master image.And then with the help of controller it can easily distinguish between presence and absence of etching. On the boring machine the vision camera are placed. As the worker are mounted the frame on the boring machine the etching at the c-section of the frame are sensed. The etching are done on the frame with the help of pneumatic inspection system. At the time of robotic inpection the etching are done on the component. In the robotic inspection the presence and absence of the part are checked and the with the help of plc-programming are given to the pneumatic etching system. This same phenomenon are used at the time of boring. When the etching are sensed on the boring machine the feedback are given to the boring with the help of plc-programming.then the boring are started. The vision sensor are sensed the etching at the very high rate in nanoseconds.

3.4 Precise Measurement sensor :

With the help of Precise measurement sensor we have measure the Internal diameter of the boring head Pipe also this sensor can measure the oversize and undersize of the component. The precise measurement sensor are mounted on the fixture to both sides. The hydraulic cylinder can move the sensor at the position of the boring head pipe and dimensions are checked and gives the reading an the digital screen. The speed of the precise measurement sesnsor is very high upto the 2 to 3 nanoseconds the dimensions are measured and result can be displayed on the screen

Demonstration Trial-

Fig 5 : Precise Measurement sensor



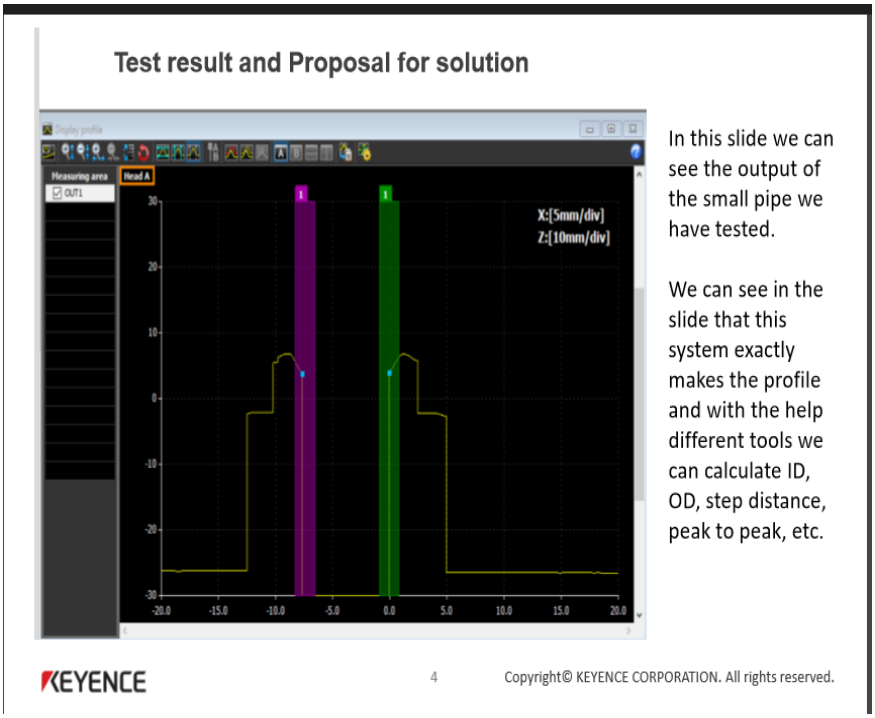


Fig 6 : Test result of Demonstration

3.5 Fixture for mounting the Precise measurement sensor :

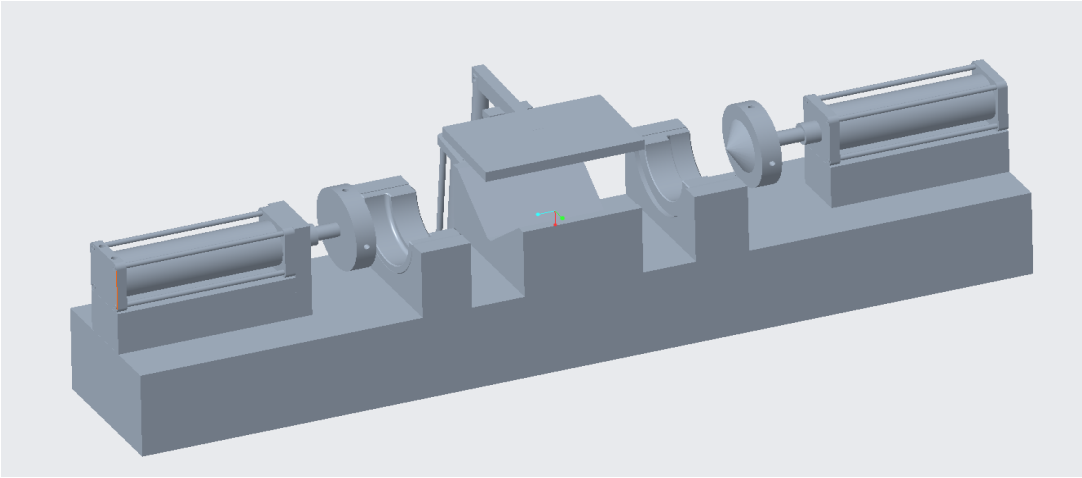
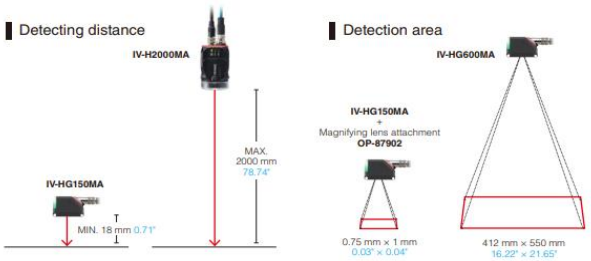
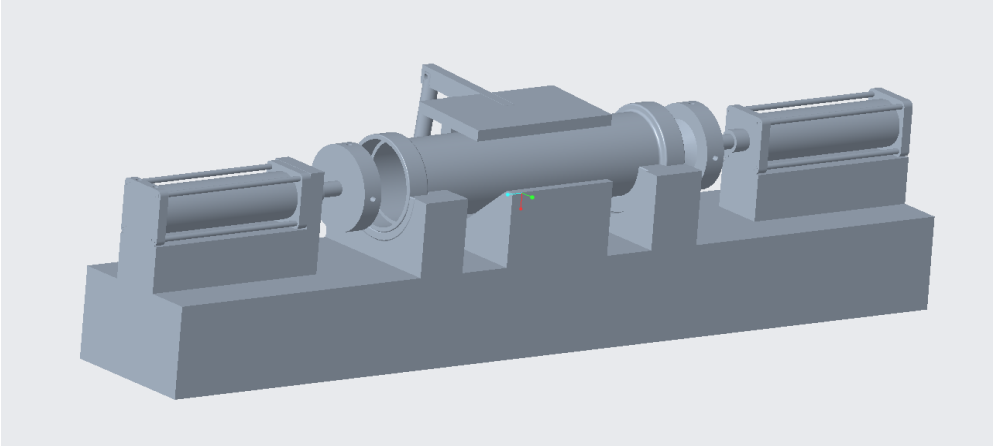


Fig 7: Design of fixture



1. This fixture is used for the measurement process of internal diameter of the head pipe.
2. Three pneumatic cylinders are used in this fixture.
3. V block is also used to align the head pipe in the centre position.
4. Nesting of the head pipe is also used to align the both head of the pipe.
5. The v block is used to restrict two degrees of freedom (Y-Y)
6. Nesting cavity is used to restrict two degree of freedom(X-X)
7. Pneumatic cylinder is used to restrict two degrees of freedom (Z-Z).
8.



3.6 Dot Marking system :

1.The system shows on above diagram can apply 55000 dots. The dots are 5mm in diameter
2.It consist of an color tank has capacity 750ml of liquid and this liquid can transfer to the spray gun.
3.The main component of this system has solenoid valve which has 3 port and 2 positions and operated on a 24 volt DC supply .

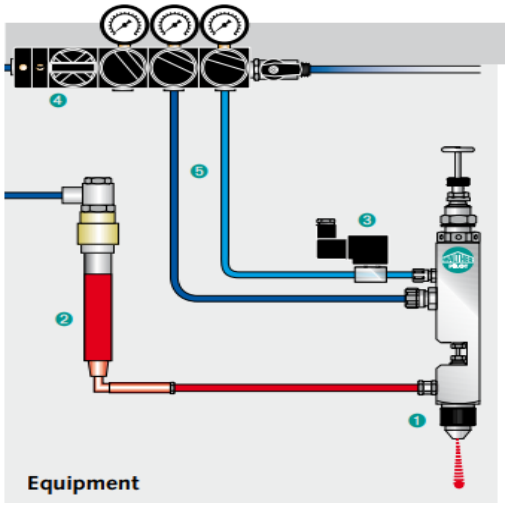


Fig 8 : Dot marking system

4. The 3 ports of solenoid valve are one for the colour tank and two for compressed air.The compressed air first clean the lubricant present on the component and the colour tank port mark the dot on a component.
5.When the marking process is finished the solenoid valve can shut off the marking gun

3.6.1 Purpose of Identification Mark

Marking parts with colored inks or stains is a quick and easy way to distinguish between similar-looking components, indicate pass-fail status, or confirm that a specific process was completed.

Manufacturers mark parts for a variety of reasons, including distinguishing between similar-looking parts, indicating that a process has been completed or a quality check has been passed, facilitating assembly, and linking a product or component to the assembly line or machine on which it was produced. Calibration screws, for example, may be marked with stains that are only visible under ultraviolet light to indicate whether they have been tampered with.

One of the most common applications of colour marking is to distinguish between parts that appear similar. Although such parts may be labelled with numbers, letters, or other identifiers, some businesses prefer to color-code them to speed and simplify identification on the shop floor. Two springs, for example, may appear identical but function very differently. A simple way to tell them apart is to mark each one with a different colour stripe.

Quality control is another important application for part s marking systems. After a test, parts are frequently marked to indicate whether or not they passed or failed. Parts are also labelled to indicate when a specific process has been completed. This is especially useful if the process does not change the parts visibly.

Marking systems are frequently integrated into testing or manufacturing fixtures. A flywheel, for example, is mounted on an engine with multiple bolts that are then tightened simultaneously. When all of the bolts have been torqued to specification, the marking device moves into position and places a dot to confirm that the operation was successful. If the dot is missing, downstream operators will be alerted that additional inspection or corrective action is required.

Color-coded parts are also commonly used to aid in assembly processes. For example, before mounting rims and tyres, assemblers may place a dot of stain on brake callipers to confirm that pads have been installed. Alternatively, a shaft could be labelled to indicate which end to insert.

Marking is also used in automotive and other stamping processes during setup to check the contours of stamped parts to indicate whether a bend has the correct radius or a crease is straight. Color marking provides an easy way to point out any discrepancies in this type of application, allowing the operator to fine-tune the press setup.

3.6.2 Marking Methods

Handheld valve-actuated markers, contact marking systems that press a stain-saturated pad against the part, and noncontact spray marking systems are all common part marking methods.

An ink or stain reservoir fitted with a pad or dauber and mounted on an air cylinder or similar device constitutes a contact marking system. The actuator advances to press the saturated dauber against the part as the part moves into position or the test or process is completed. Depending on the marking fluid, the parts may need to be cleaned and dried before applying the mark.

To apply spots, stripes, and bands, noncontact marking systems typically employ a pneumatic spray valve with stain supplied from a tank or disposable reservoir. The valve can be mounted in a fixed location or attached to an actuator that moves it to the part, depending on the application. In some processes, the part is rotated while the valve applies a band of color around the outer circumference.

3.6.3 Choosing a Marking System

When comparing contact and noncontact marking systems, engineers should consider ,

1. Marking speed
2. The cost of the marking fluid and need to maintain inventory
3. The requirement to regularly monitor the system to ensure that ink is present in the bottle. vs. using a tank that can be filled once at the start of a shift.
4. Time needed to change ink bottles or refill a tank and whether the line must be shut down to do this.
5. Replacement of contaminated or dried out pads and daubers takes time and money.

3.6.4 Dot Mark with paint spray technology

The applications for dot or bar codes vary widely. The fact that the marks are applied without touching the object is the primary advantage of the paint spraying process.That is one reason why the process is preferred for marking for objects in the metals and plastics processing industries. Markings can be used to express any attitude or orientation. Special spray gun configurations are also available to distinguish classifications with different colours. This enables encoding as per any of a number of criteria.

Fig.8.1. Paint spray technology.

To apply alphanumeric characters, pneumatic and electromagnetically driven marking blocks are available. These large-character printers typically have four to nine spray nozzles. Special configurations can be assembled.

3.6.5 Equipment

- Marking spray gun, Model 20-360, with pull rod for manual activation (e.g. for spray trials) Body: nickel-plated brass; nozzle and needle: stainless steel; nozzle sizes: 0.3, 0.5, 0.8, 1.0, 1.2, diameter 1.5 mm
- Miniature material pressure tank, stainless steel, 45 mL, max. 3 bar
- Solenoid valve, 3-port, 2-position, 24 V DC; other voltages available
- Manifold for compressed air with pressure gauges and a safety valve All compressed air control functions are combined for simpler marking systems (control and spraying air for the spray gun, tank pressurisation air)
- Hose kit (2 m), including fittings for both the air and material hoses

3.6.6 Spray gun

Special-design spray guns for special materials Rugged, fully-automatic marking guns using a diaphragm instead of a needle seal. Particularly suitable when processing abrasive or moisture-curing materials. High cycle rate. Air caps: round or wide pattern. Nozzle sizes as required: 0.3, 0.5, 0.8, 1.0, 1.2, 1.5 mm in diameter A marking gun has to withstand the most extreme loading: continuous opening and closing at the shortest possible intervals. This will cause accelerated wear at the needle seal, particularly when handling abrasive media. Substituting a special diaphragm for the needle will lengthen service life significantly. We would be glad to provide information on the technical details. Additional alternates when using moisture-curing materials: spray guns using Mesa moll lubricant Fully automatic spray gun.

Fig.8.2 spray gun.

Forward body and all wetted components made of Hastelloy alloy. Especially suitable for use with acidic or basic materials. Mesa moll lubrication effectively reduces needle packing wear. Material volume regulation by way of detent adjustment.

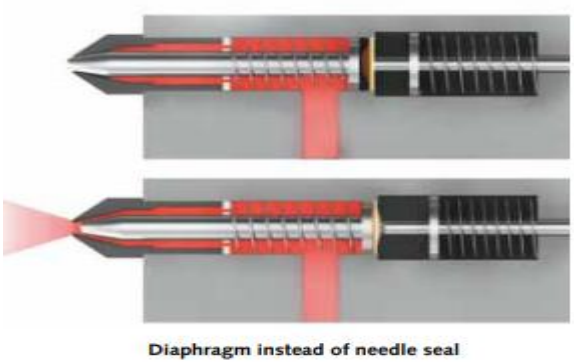


Fig. 8.3 working of spray gun

3.6.7 PAINTS

Standard paints, inks, thinners n The pigments in marking paints are especially finely ground so that, They are more resistant to settling out and clogging in and around the nozzle when compared to other surface coatings. These are all environmentally friendly products, for example, alcohol-based. Benefits include quick drying, clear marking dots, and UV resistance. The paints can be used on surfaces that are wet or dry, hot or cold, light or dark, porous or smooth, and even on greasy surfaces. n They can be used, for instance, on sheet metal, pipes, plastics, textiles, glass, stone, wood, paper, ceramics and rubber. n All the standard shades and fluorescent paints are available. Special shades and applications on request.

Fig.8.4 Ink containers

Type WPF 1922 Alcohol-based marking paint with reduced settling, fast drying, various shades as required. WPV 0218 is a suitable thinner. WPF 0232 Solvent-based marking paint with low settling and rapid drying. VPV 0222 is a suitable thinner. Typ WPT 1800 Marking ink, alcohol-based, non-settling, fast-drying.

3.6.8 PILOT

Fig.8.5 Pilot

Special-design spray guns for limited spaces Spray nozzles of the smallest possible dimensions, with external control of the atomization parameters. All the wetted components are made of stainless steel. Material volume control. Round or wide jet nozzles available. Nozzle sizes as required: 0.3, 0.5, 0.8, 1.0, 1.2, 1.5 mm in diameter

3.6.9 TANKS

Fig. 8.6 Tanks

Small tanks, Model MDG or LDG, made of stainless steel are often used for marking tasks. They ensure pulse-free delivery of the material. The tanks are suitable for accepting the original drums. We can also provide consumables (paints, inks, cleaning agents). Over and above that, WALTHER PILOT can supply tanks in many standard and special sizes. In regard to safety, too, our tanks are designed to satisfy every requirement (Pressurized Vessel Regulation / ATEX Explosion Protection Directive). Agitators and fill level measurement sensors can also be installed in the smaller tanks without difficulty.

3.6.10 Control unit

We will design a configuration matched to your specific production requirements. n Pneumatic control cabinet n Electro-pneumatic control cabinet n Electrical control cabinet All the components required to integrate these control elements into the system – such as mounting stands or frames – can also be obtained from us.

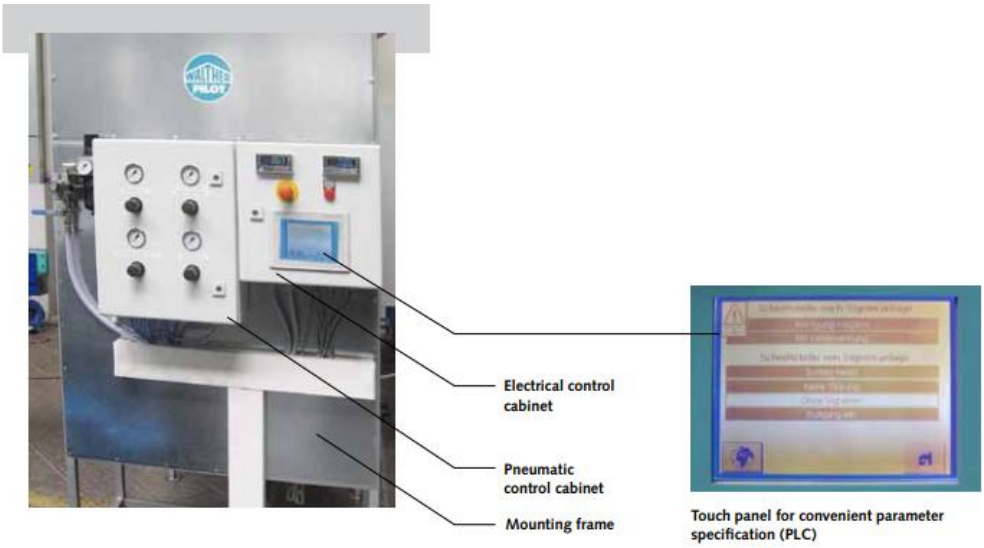


Fig 8.7. Control Panel

Cabinets for the materials delivery technology including, if indicated, Sumps for use when handling hazardous liquids; controls for regulated exhaust of noxious gases or fumes that could be released when pressure tanks are opened. n After each spray cycle, marking guns with a flushing system clean the outside of the nozzles.

Spray booths for solvent fumes and overspray. Multi-layer paper filters with high absorption capacity. n Color sensors and measurement transducers are used to monitor functions. They provide assurance that the dot or bar code was actually applied and avoids faulty coatings and rejects. n Control technology: Control cabinets (pneumatic, electro-pneumatic, electrical) exactly suited to your needs. n Space-saving integration of the marking system into existing or projected production lines. Expert engineering, all from a single source.

3.7 colour Sensor

Fig.9 colour sensor

Unlike conventional sensors which only use a Red LED, the LR-W utilises a White LED and the full colour spectrum. As a result, the LR-W can reliably and consistently distinguish a much broader range of targets.
By utilising a High Powered White LED, the LR-W ensures detection of dark targets. For glossy targets, the LR-W features an Automatic Power Control function that optimises the sensor's power and sensitivity to ensure stable detection. the color sensors include filters to block unwanted IR light in the visible spectral range, enabling highly accurate color measurement. Because of their high sensitivity and wide dynamic range, they are well suited to continuous colour temperature measurement of ambient light in display management systems, as well as automatic-white-balance assistance in camera applications. Some products include additional infrared channels to aid in the identification of infrared light sources.

4.0 Cost estimation

Sr.no	Name of component	Quantity	Cost
1	Vision sensor	1	4 lac
2	Precise measurement sensor	2	5 lac
3	Dot marking system	1	10 k
4	Dot Recognisition sensor	1	2k
5	Fixture	1	10 k
Total			9.22 lacs

4.1 Payback period :
Number of frames rejection per month Avg.10
Cost of frame : 1500/frame
Cost of penalty 15000/ month
Cost of penalty per year 180000
Cost of Rework on frame 50000 /year
Total cost 230000/year
Investment in project 9.2 lac.
Therefore payback period 4 years.

5.0 Benefits

KEY PERFORMANCE INDICATOR according to TPM :

P	Q	C	D	S	M
Rejection of the frame reduced, increase in Ok Quantity. Therefore increase in productivity	Reduction in the Rejection ,so improvement in quality	Cost required to spend on the rework of the rejected frame is save completely.	On time delivery	Safe workplace made. Less envolvement of the human in process.	Reduction in fatigue of worker occur due to measurement of ID by hand.

Fig: PQCDSM Chart

5.2 To industry:

This system does not affect the productivity and quality of the product.
Also does not affect the machining time of the frame.
The bored component easily identified by the worker
Unbored component will not supply to the customers
Low initial investment required for the system.
Low maintenance

5.3 To students:

Hand on experience
Real time problem solving ability
Learn actual problem faced with industry.
Learn how to apply theoretical knowledge to solving real time industry problems.

6.0 Conclusion:

These monitoring system not only check the frame but also controls the rejected frame(unbored frame)from getting supply to the customer end
Also this system will definitely reduce the customer complaints.

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