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Design and development of industrial receiver gauge in coordinate measuring machine for reducing inspection time

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ABSTRACT

The coordinate measuring machine (CMM) is a mechanical system that moves a measuring probe to determine the coordinates of points on the surface of a workpiece. The CMM comprises: the machine itself; the measuring probe; the control system, and the measuring software. CMM is a precious excellence control to manufacturing, its precision along with repeatability must be better than the tolerance condition of the part being inspected. The primary objective of our project is to reduce inspection time of–CMM using receiver gauge**.** It is the process of increasing the pin diameter of receiver gauge. A receiver gauge refers to an examination tool used to make sure a workpiece alongside its authorized tolerances. The pin diameter in the receiver gauge is to increase according to position tolerance of the pin. We undergo some calculation to increase the diameter of the pin by reducing the position tolerance from 100% to 50%. So the diameter of every pin in the receiver gauge is increased. The mathematical calculations for all pins are done with the position tolerance. Therefore the inspection time of co-ordinate measuring machine is reduced by increasing the diameter of receiver gauge is increased according to the position tolerance.

Keywords: CMM; Receiver gauge; Design and development; Inspection time:

1. INTRODUCTION

The rising demands of industry for superior accuracy measurements of micro system contain led to the growth of the field micro in addition to nano dimensional metrology [1]. Activity is approved to verify the position of a physical thing with respect to its theoretical definition. The parameters taken into thought to compare the object feature to its nominal description are Dimension, Form, Orientation as well as Position [2] [3] [4].

Coordinate Measuring Machine (CMM) is a measuring machine to discover the coordinates of point on a job surface by gradual movement of measuring probe [5] [6]. It is an in service unit able to positioning the sensorial part in any point of its operational volume in an enormously repeatable mode. The mechanical arrangement is just one of the four basic modules of a CMM. Parameters incorporated in Mechanical Structure are Dimensions [7] [8] [9].

The main aim is an evaluation to provide the participants with calibrated substance as well as procedures for verifying the real metrological recital of their optical CMMs. The comparison helped to get better the measuring ability of industrial participants revealing a diversity of error sources that can be abolished into account in formative uncertainties.

2. MECHANICAL STRUCTURE OF CMM:

CMM is an operating unit “Manually” or “Numerically” controlled, capable of positioning the sensorial element in any point of its working volume in an extremely repeatable mode. Figure 1 shows the CMM.

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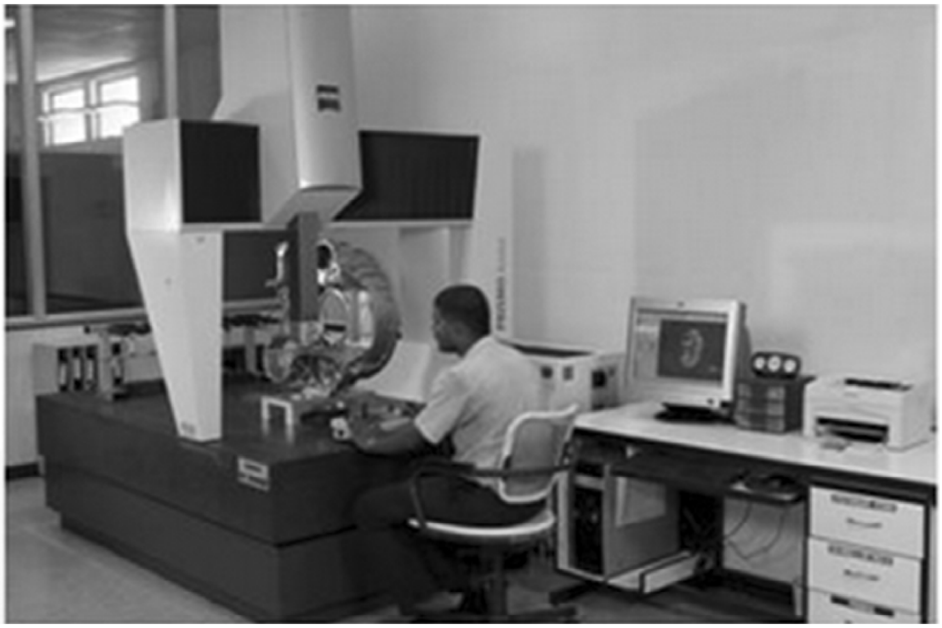

Figure 1: Co-ordinate Measuring Machine

Generally referred to as "machine", the mechanical structure is just one of the four fundamental modules of a CMM.

Parameters included in Mechanical Structure are Dimensions: determine the "Measuring Volume" of the structure. Architecture: designed to optimize "Dynamics" (speed of the CMM). Some of the consolidated architectures for CMM are: Cantilever with fixed table Moving Bridge and Fixed bridge Gantry Moving ram horizontal arm Articulated arm.

3. RECEIVER GAUGE

A gauge is a device used to make measurements or in order to display certain information, like time. A wide variety of tools exist which serve such functions, ranging from simple pieces of material against which sizes can be measured to complex pieces of machinery. The receiver gauge refers to an inspection device used to check a workpiece against its allowed tolerances. Its name derives from its use: the gauge has two tests; the check involves the workpiece having to pass one test (*Go*) and fail the other (*No Go*)It is an integral part of the quality process that is used in the manufacturing industry to ensure inter changeability of parts between processes, or even between different manufacturers. A Go, No Go gauge is a measuring tool that does not return a size in the conventional sense, but instead returns a state. The state is either acceptable (the part is within tolerance and may be used) or it is unacceptable (and must be rejected).

3.1. Industrial Receiver Gauge

With our expertise in the respective domain, we are involved in offering a wide range of Industrial Receiver Gauges. Manufactured at par with the latest technological advancements in the market, the gauges ensure to provide accurate measurement of pressure and temperature. Available in various dial sizes and range, the sensing element used in the system is high grade Metal.

3.2. Specifications of Receiver Gauge

1. Location pin 2. Orientation pin 3. Position pin 4. Budding bed 5. Clamping pin

The receiver gauge for stiffener is shown in Figure 2.

Location pin always denoted as (H1), orientation pin (H2) and the position pins (H3, H4, H5, H6).

3.3. CAD Diagram of Location & orientation (H1&H2) and position pins (H3, H4, H5, H6)

The CAD diagrams of location, orientation and position pins are shown in Figure 3 and 4, 5 respectively.

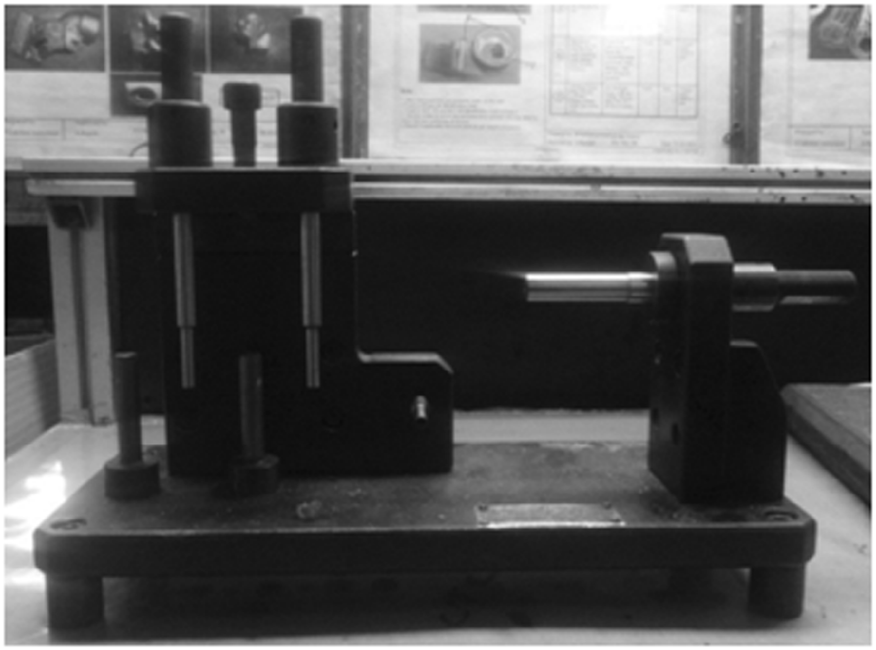

Figure 2: Receiver gauge for stiffener

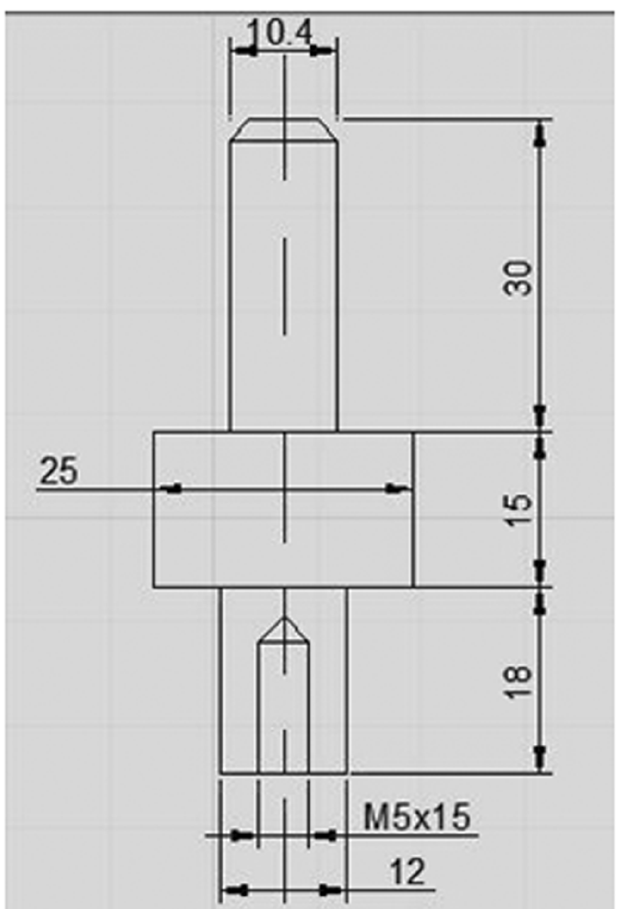

Figure 3: CAD Diagram of Location and orientation pin (H1&H2)

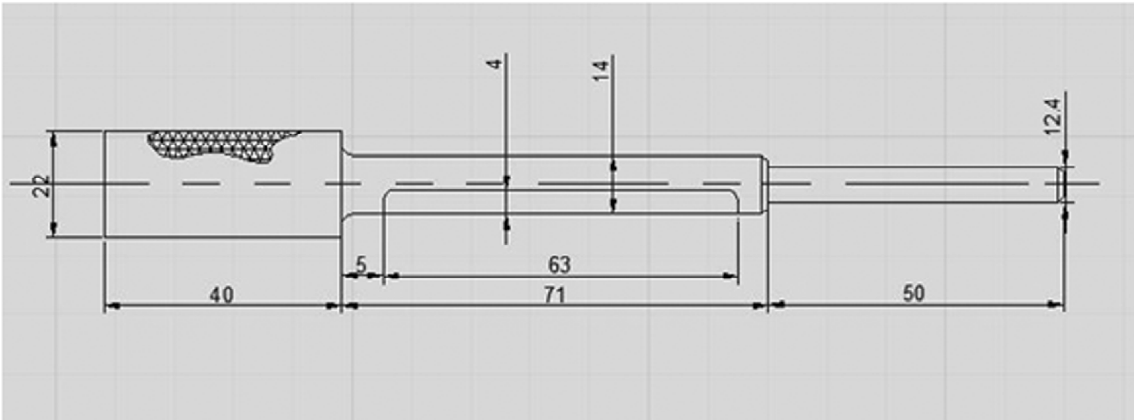

Figure 4: Position pin (H3&H4)

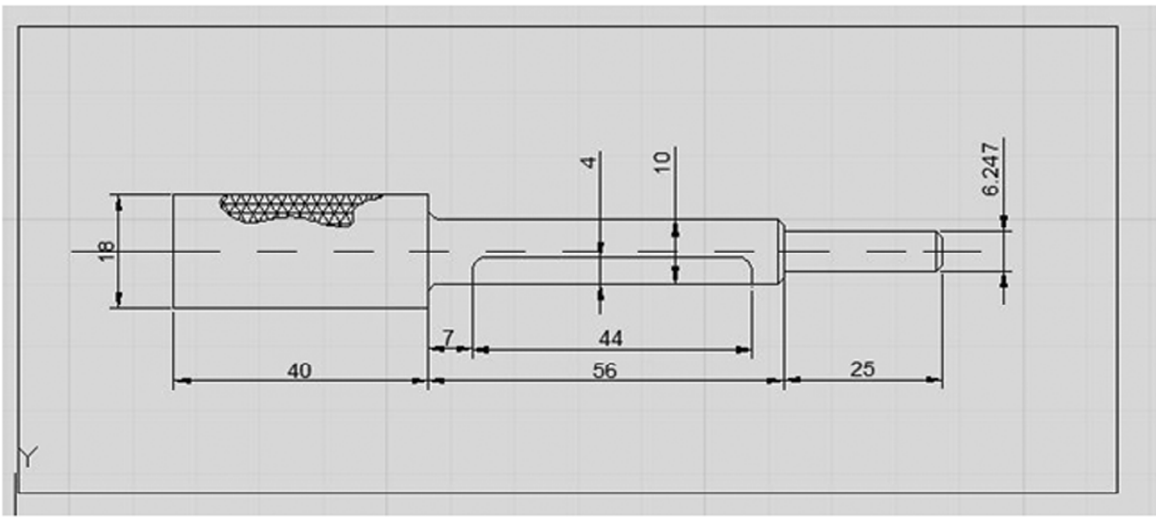

Figure 5: Position pin (H5 & H6)

3.4. Product Details

3.4.1. Part 1: Stiffener

Figure 6 shows the part diagram of the stiffener.

Figure 6: Stiffener (Part diagram)

Part Name	:	STIFFENER
Part no	:	21231347
Customer	:	Volvo
Material	:	Aluminium
Net weight	:	1 kg
Process	:	Gravity Die Casting
Supplied in	:	Machined condition
Application	:	Diesel engine
Ave monthly demand	:	6000 No

3.4.2. Receiver gauge pin modification details

Locating pin calculation (H1)

Hole size = $Ø11^{\pm 0.2}$

Min.size = Ø10.8

Pin size = $Ø10.8^{-0.02}$mm

Orientation pin (H2)

Hole size	=	$Ø11^{\pm 0.2}$
Min.size	=	Ø10.8
Position tolerance	=	0.4
Pin size	=	$Ø10.4^{+0.01}$mm
50% position tolerance	=	0.2
Pin size	=	$Ø10.6^{+0.01}$mm

Pin size @100% of position tolerance	Pin size @50% of position tolerance
$Ø10.4^{+0.01}$mm	$Ø10.6^{+0.01}$mm

Gauge pin (H3-H4-H5)

Hole size	=	M18*1.25
Core size	=	Ø6.647/6.912
Position tolerance	=	0.4
50% of position tolerance	=	0.2
Pin size	=	Ø6.447

Pin size @100% of position tolerance	Pin size @50% of position tolerance
Ø6.247mm	Ø6.447mm

Gauge pin (H6)

Hole size	=	$Ø13^{\pm 0.2}$
Min.size	=	Ø12.8
Position tolerance	=	0.4
Pin size	=	$Ø12.4^{+0.02}$mm
50% position tolerance	=	0.2
Pin size	=	$Ø12.6^{+0.01}$mm

Pin size @100% of position tolerance	Pin size @50% of position tolerance
$Ø12.4^{+0.01}$mm	$Ø12.6^{+0.01}$mm

Figure 7 shows the receiver gauge pin with 50% position tolerance.

Figure 7: of the receiver gauge pin with 50% position tolerance

H1	–	locating pin.
H2	–	oreintation pin.
H3, H4, H5, H6	–	Gauge pin.

Figure 8 shows the receiver gauge, pin, and part, after the diameter of the gauge pin increased to 50% according to the position tolerance.

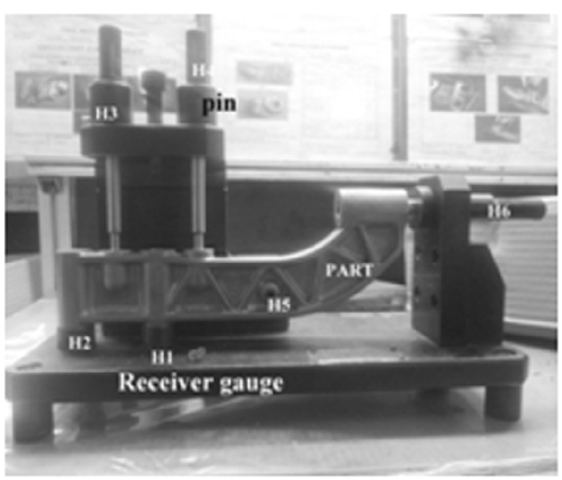

Figure 8: The receiver gauge with part and pins

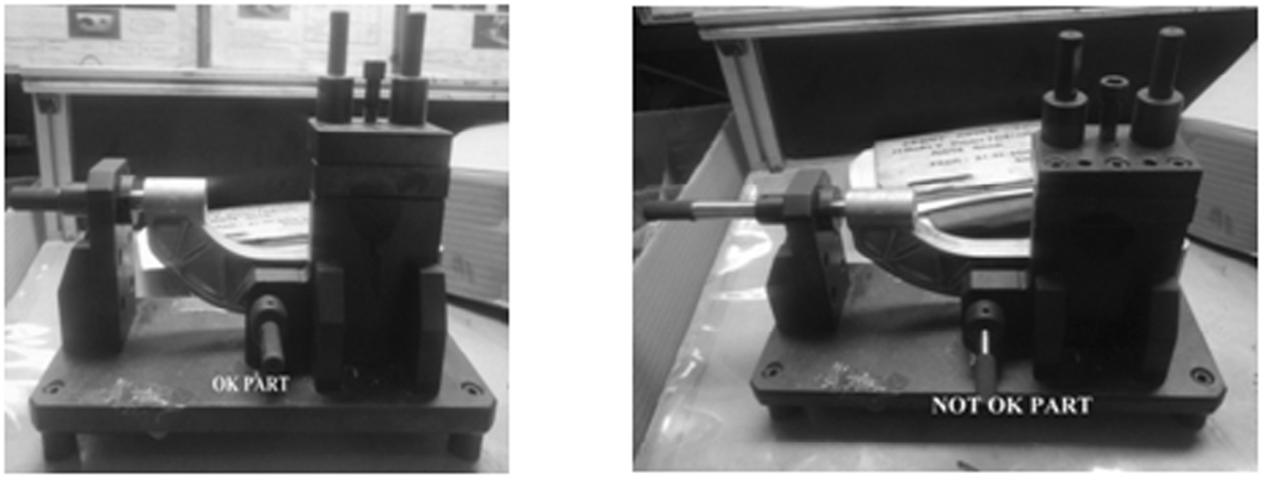

Figure 9: ok & not ok component with receiver gauge

Ok and not ok component with receiver gauge is shown in Figure 9.

This receiver gauge shows that position of the (H5) holes are out of specification in the not ok job or part checked in CMM

3.4.3. Part -2: ISX-oil Filter Cooler-cmm Time Reduction

Product Details:

Part Name : ISX Oil Filter Cooler

Part No : 4965895

Customer : Cummins

Material : Aluminium

Supplied In : Machined Condition

Process : Gravity Die Casting

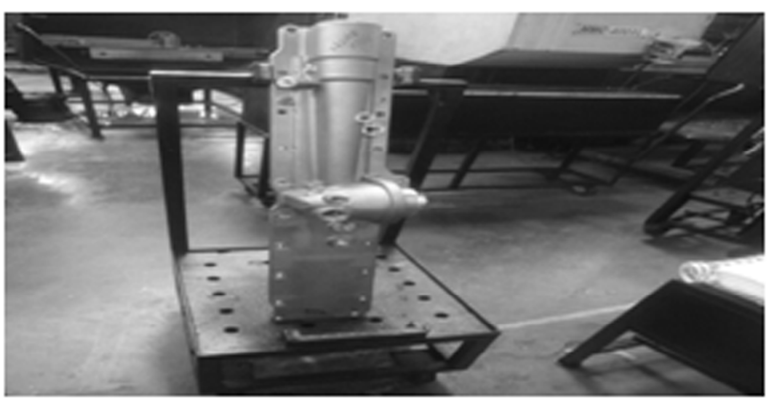

Figure 10: Part diagram of ISX-Oil filter cooler

List of CMM dependant dimensions in ISX-OFC:

- ➢ 14*Mounting holes position
- ➢ 6*B Flange thread hole position
- ➢ 6*c Flange thread hole position

Total inspection time in CMM 60 Minutes

Concept Adopted

Modify the receiver gauge pins taking the nominal diameter of the bore and 50% of the positional tolerance.

Pin diameter calculation:

Before:

Pin = Min of bore–100% Position tolerance

After:

Pin = Nominal of bore–50% Position tolerance

Mounting hole

Drawing specification = 18.25[- or +]0.25

Position tolerance = 0.85

Receiver Gauge Pin Modification Details:

Before

Min. dia. = 18.00-100%position tolerance

= 18.00-0.85

= 17.15

After

Nominal dia. = 18.25-50%position tolerance

= 18.25-0.42

= 17.83

Reference	characteristics	Specification	No. of Holes
18.25	position	0.85	14

Inference

Receiver gauge can detect part produced with 0.83 positional tolerance.

Before

Figure 11 shows before pin modification, the pins are not properly linked with required part.

Figure 11: Before pin modification the pins are not properly linked with required part

After:

Figure 12 shows after pin modification the pins are properly linked with required part

Figure 12: After pin modification the pins are properly linked with required part

3.4.4. Part 3: AFSOV- Cmm Time Reduction

Product Details:

Part Name	:	AFSOV-TRX VARIENT
Part No	:	A042P955/A
Customer	:	CUMMINS
Material	:	ALUMINIUM
Supplied In	:	MACHINED CONDITION
Process	:	GRAVITY DIE CASTING
Avg. Monthly Demand	:	5000 NO.S

Total inspection time in CMM 60 Minutes.

Figure 13 shows the part diagram of AFSOV.

Figure 13: Part diagram of AFSOV

Concept adopted

Modify the receiver gauge pins taking the nominal diameter of the bore and 50% of the positional tolerance.

Pin Diameter Calculation:

Before:

Pin = Min of bore – 100% Position tolerance

After:

Pin = Nominal of bore – 50% Position tolerance

Pin Model Calculation

Orientation pin (H2):

Hole size = 11 (+ or -) 0.03

Minimum dia. = 10.97

True position = 0.02 (50%)

Nominal size = 11.00

Pin dia. = 11.00 – 0.02

= 10.99

H2 $\rightarrow 10.95^{-0.01} \rightarrow 10.99 \rightarrow 10.99+0.01 \rightarrow 11.00$

Locating pin (H1):

Hole size = 11 (+ or -) 0.03

Minimum dia. = 10.97

True position = 0.02 (50%)

Nominal size = 11.00

Pin dia. = 11.00 – 0.02

= 10.99

H1 $\rightarrow 10.95^{-0.01} \rightarrow 10.99 \rightarrow 10.99+0.01 \rightarrow 11.00$

Gauge pin (H3-H6, H16):

Hole size = 25 (+ or -) 0.25

Minimum dia. = 24.75

True position = 0.25 (50%)

Nominal size = 25.00

Pin dia. = 25.00 – 0.25

= 24.75

(H3-H6, H16) $\rightarrow 24.25^{-0.01} \rightarrow 24.75 \rightarrow 24.75+0.01 \rightarrow 24.76$

Gauge pin (H7-H10):

Hole size = M14*1.5-6H
= 12676/12.376
Minimum dia. = 12.376
True position = 0.25 (50%)
Nominal size = 12.526
Pin dia. = 12.526 – 0.25
= 12.276
(H7-H10) $\rightarrow 11.87^{-0.01} \rightarrow 12.276 \rightarrow 12.276+0.01 \rightarrow 12.286$

Gauge pin (H11):

Hole size = M27*2-6H
= 25.210/24.835
Minimum dia = 24.835
True position = 0.25 (50%)
Nominal size = 25.023
Pin dia. = 25.023 – 0.25
= 24.773
(H11) $\rightarrow 24.335^{-0.01} \rightarrow 24.773 \rightarrow 24.773+0.01 \rightarrow 24.783$

Gauge pin (H12):

Hole size = M10*1.5-6H
= 8.766/8.376
Minimum dia. = 8.376
True position = 0.25 (50%)
Nominal size = 8.576
Pin dia. = 8.576 – 0.25
= 8.326
(H12) $\rightarrow 7.876^{-0.01} \rightarrow 8.326 \rightarrow 8.326+0.01 \rightarrow 8.336$

Gauge pin (H13):

Hole size = 58 (+ or -) 0.1
Minimum dia. = 57.90
True position = 0.25 (50%)
Nominal size = 58.00
Pin dia. = 58.00 – 0.25
= 57.75
(H13) $\rightarrow 57.40^{-0.01} \rightarrow 57.75 \rightarrow 57.75+0.01 \rightarrow 57.76$

Gauge pin (H14):

Hole size	=	M16*1.5-6H
	=	14.676/14.376
Minimum dia.	=	14.376
True position	=	0.25 (50%)
Nominal size	=	14.526
Pin dia.	=	14.526 – 0.25
	=	14.276
		(H14) $\rightarrow 13.876^{-0.01} \rightarrow 14.276 \rightarrow 14.276+0.01 \rightarrow 14.286$

BEFORE

Figure 14 shows before pin modification the pins are not properly linked with required part.

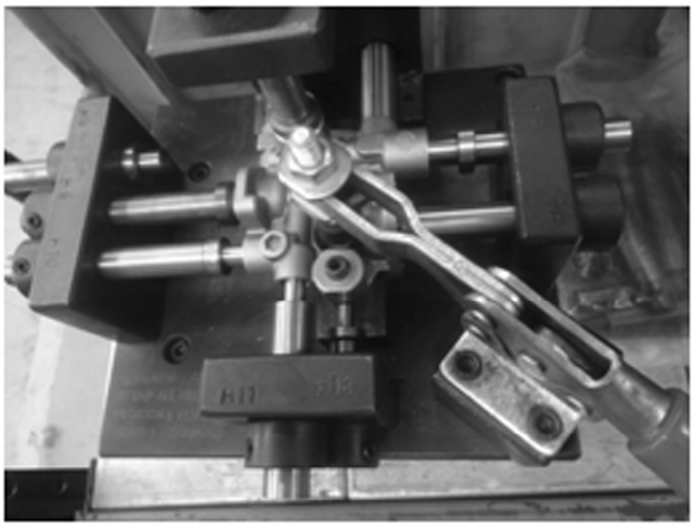

Figure 14: Before pin modification the pins are not properly linked with required part

AFTER

Figure 15 shows after pin modification the pins are properly linked with required part.

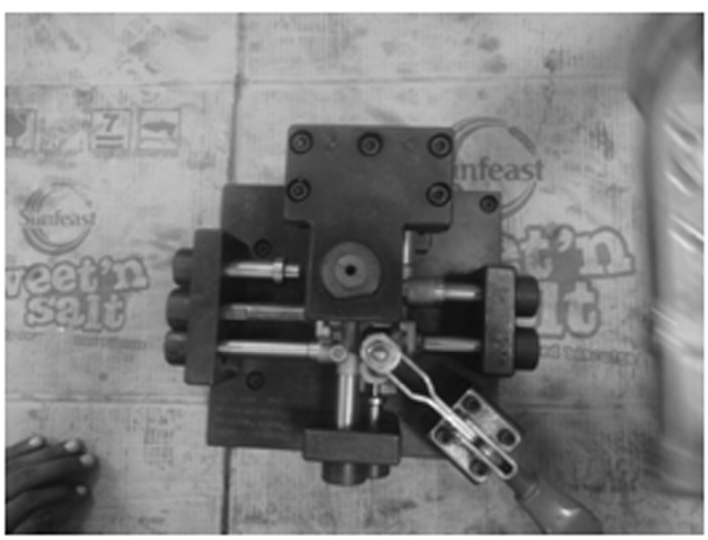

Figure 15: After pin modification the pins are properly linked with required part

3.4.5. Some Reciver Gauge Pin Modification Details

Table 1 shows the some receiver gauge pin modification details.

Table 1
Some receiver gauge pin modification details

Cell	Sl. no	SCFGno.	PinName	Pinsize	Nomi.	TP100%	TP 50%	Pin dia.	PD + 0.01	Qty.
HRL	1	1777	H3-H8	5.847	6.698	0.8	0.4	6.298	6.308	6Pins
			H9-H13	12.46	12.963	0.5	0.25	12.713	12.723	5Pins
	2	1798	H3-H19	3.9	5	1	0.5	4.5	4.51	17Pins
DCX-LOFH	3	676		7.935	8.75	0.8	0.4	8.35	8.36	2Pins
				5.25	5.75	0.5	0.25	5.5	5.51	1Pin
	4	677		9.27	10.526	1.25	0.625	9.901	9.911	1Pin
				19.75	20.32	0.5	0.25	20.07	20.08	1Pin
	5	681		20.05	23.05	0.8	0.4	23.58	23.59	1Pin
ISX-HOFC	6	1833	H7-H10	11.88	12.526	0.5	0.25	12.276	12.286	4Pins
				24.34	25.023	0.5	0.25	24.773	24.783	1Pin
				7.876	8.576	0.5	0.25	8.326	8.334	1Pin
				57.4	58	0.5	0.25	57.75	57.76	1Pin
				13.88	14.526	0.5	0.25	14.276	14.286	1Pin
				24.25	25	0.5	0.25	24.75	24.76	4Pins
				10.95	11	0.02	0.01	10.99	11	1PIN
PFFH	7	2859		16.6	17.4	0.7	0.35	17.05	17.06	4Pins
				26.05	27	0.7	0.35	26.65	26.66	1Pin
	8	4817		6.1	6.5	0.4	0.2	6.3	6.31	2Pins
				8.45	8.75	0.3	0.15	8.6	8.61	4Pins
ISX-FWH	9	522		17.1	18.25	0.9	0.45	17.8	17.81	12Pins
	10	526		511.1	511.18	0.15	0.075	511.11	511.12	12Pins
				7.614	9.347	1.53	0.765	8.582	8.582	5Pins
MFH	11	2988		510.8	511.3	0.5	0.25	511.04	5,11,06	1Pin
				8.644	9.3472	0.5	0.25	9.0972	9.1O7	2Pins
HR	12	3771		8.45	8.75	0.3	0.15	8.6	8.61	2Pins
AFSOV	13	4625		6.8	7	0.2	0.1	6.9	6.91	1Pin
				12.4	13	0.6	0.3	12.7	12.71	1Pin
				11.77	12.376	0.6	0.3	12.076	12.086	1Pin
				8.317	9	0.6	0.3	8.7	8.71	4Pins
				11.4	12.022	0.6	0.3	11.722	11.732	1Pin
				12.32	13	0.6	0.3	12.7	12.71	1Pin
GH	14	1150		8.8	9.7	0.9	0.45	9.25	9.26	11Pins
				8.9	9.7	0.8	0.4	9.3	9.31	6Pins
				4.235	5.035	0.8	0.4	4.635	4.645	2Pins
FFH	15	2781		8.435	9	0.565	0.283	8.7175	8.7275	1Pin
				19.94	20.5	0.565	0.283	20.22	20.228	1Pin
				13.09	14.5	1.414	0.707	13.793	13.803	1Pin
				5.336	6.75	1.414	0.707	6.043	6.053	1Pin
				6.185	6.75	0.565	0.283	6.4675	6.4675	1Pin
				8.435	9	0.565	0.283	8.7175	8.7275	1Pin

4. CONCLUSION

Thus the pin diameter in the receiver gauge is to increase according to position tolerance of the pin. We undergo some calculation to increase the diameter of the pin by reducing the position tolerance from 100% to 50%.so the diameter of every pin in the receiver gauge is increased. The mathematical calculation for all pins done with the position tolerance.

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