Design for Battery Loader

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- UG model explanation
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- Expected efficiency of new device

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Subject definition

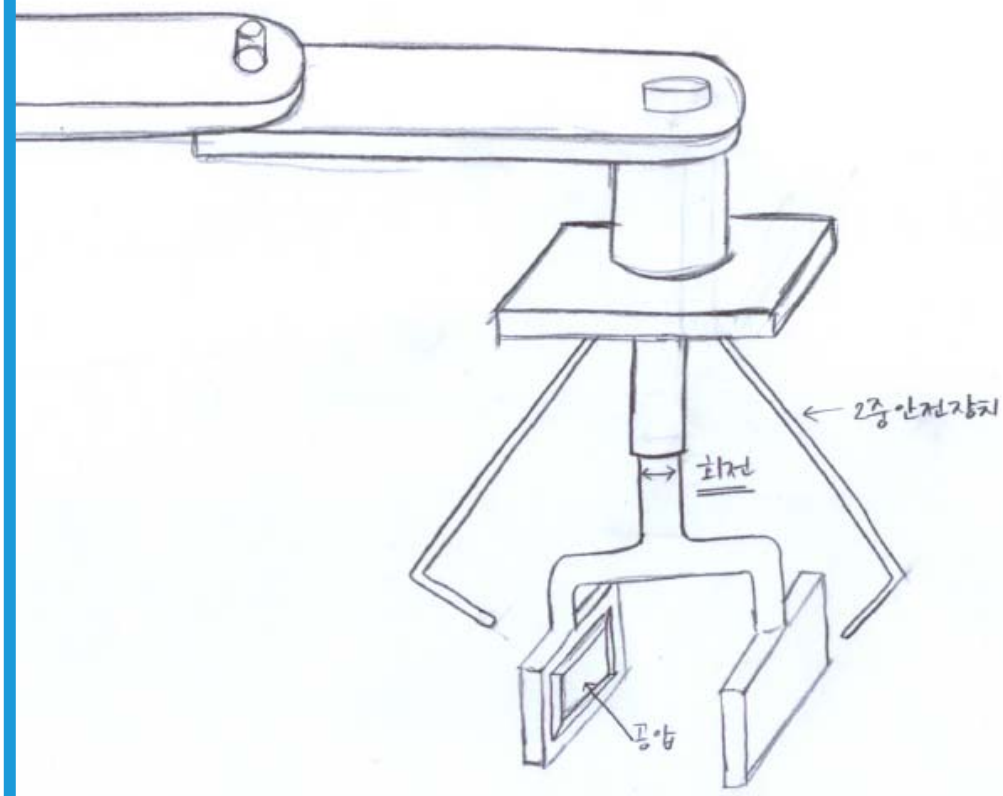
Cooperation of battery loader

There are two batteries with different size and weight
BM-70(14kg), BM-85(18kg) - for two kinds of vehicles.

1. It should take in a minute for assembling batteries
2. There should be no interference with the car body or anything during work.
3. Workers do not lift batteries during assembling process.
4. Batteries should not be fallen during assembling process.
5. An examination and a detailed model for every little thing including running gears for equipment should be processed.

Concept plan

Fig. 1



concept plan

Ideas and reason

① Use of joints

- Fluent working space security for machines and elimination of interference

② Use air pressure for clamps parts (cuffs of tonometer)

- Plastic body protection

③ Use of rotation plate

- Elimination of interference when batteries are assembled

④ Safety device addition

- Prevention of falling risk

⑤ Soft movement of clamps

- Realization of cooperation based on same width of the batteries

UG model explanation

1. Detailed plan step 1

- Change detailed plan based on inspection of conception plan for PBL2

Reason

① It can be transported safely with just holding capacity of clamps
→ elimination of additional safety device

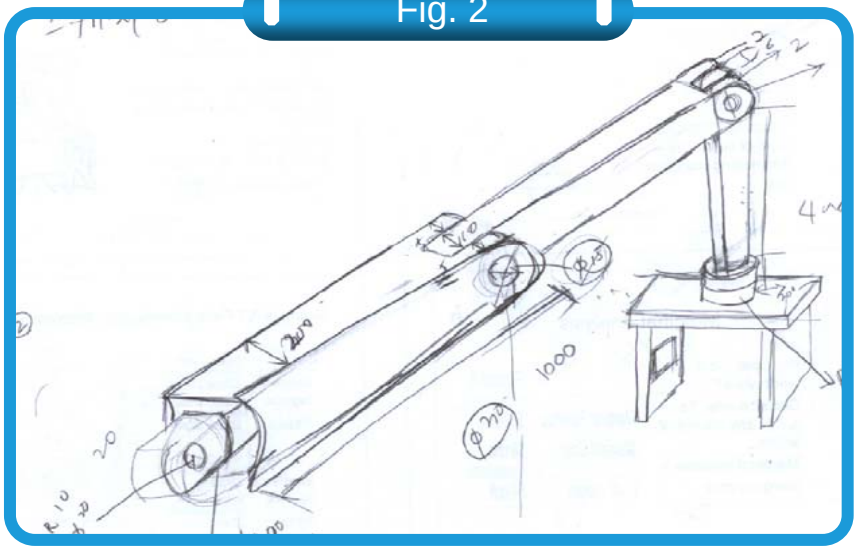
② change use of air pressure (which was presented during conception plan) for vacuum pump device
→ improvement of both safety and transport capacity

③ working space reduction based on increase of radius of right and left rotation for robot's arm

2. Detailed plan step 2

- Robot's detailed plan based on concept plan modification

Fig. 2

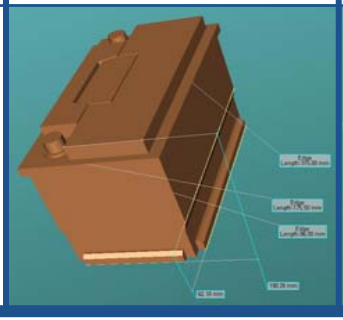
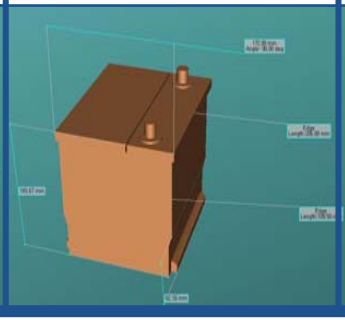
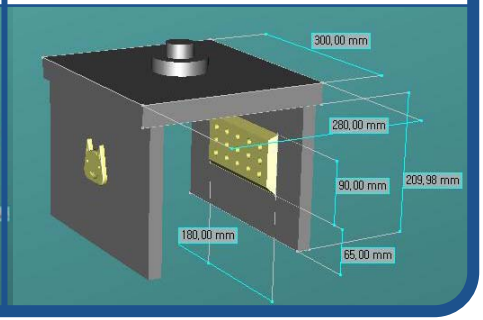


UG model explanation

3. Holding part design

① Two clamps tie the battery primarily on both sides. Vacuum plate should be arranged in consideration that battery's sides are not flat.

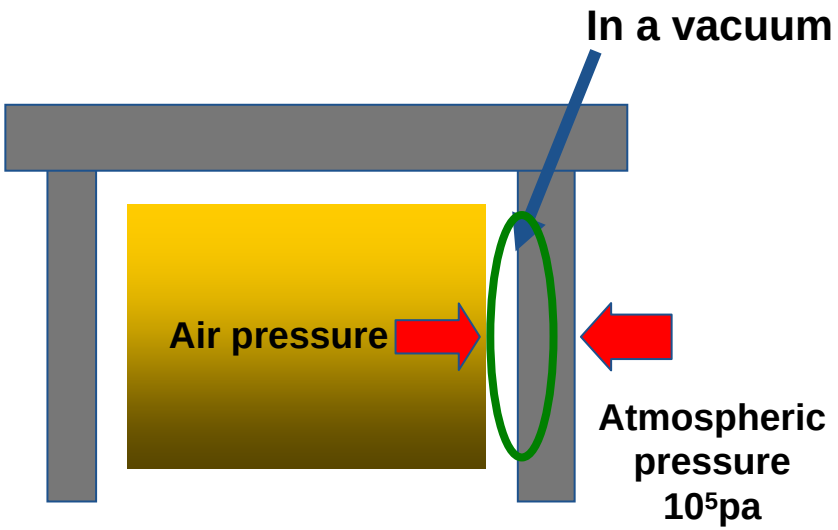
(unit : mm)

Comparison	BM-70	BM-85	Gripper
Width	315.00	206.00	300.00
Length	175.50	172.00	280.00
Height	190.26	183.67	209.98
Catching space height	62.16	62.16	65.00
contact surface width	-	-	180.00
contact surface length	-	-	90.00
Weight	14kg	18kg	-
Snapshot			

UG model explanation

4. Use air pressure

① Verification of Using air pressure



② General Use of air pressure

Classification of air pressure	Pressure (Pa)	Applied field
Low air pressure	10^5 (atmospheric pressure) ~ 10^2	Mechanical engineering, Food engineering
Medium air pressure	10^2 ~ 10^{-1}	Electronics, Optical vacuum metallurgy
High air pressure	10^{-1} ~ 10^{-5}	Semiconductor, laser optics
Super high air pressure	10^{-5} ~ 10^{-10}	Semiconductor, Accelerator, Space science, Surface science
Extremely high air pressure	Below 10^{-10}	Space science, Next generation element, Study of elementary particle

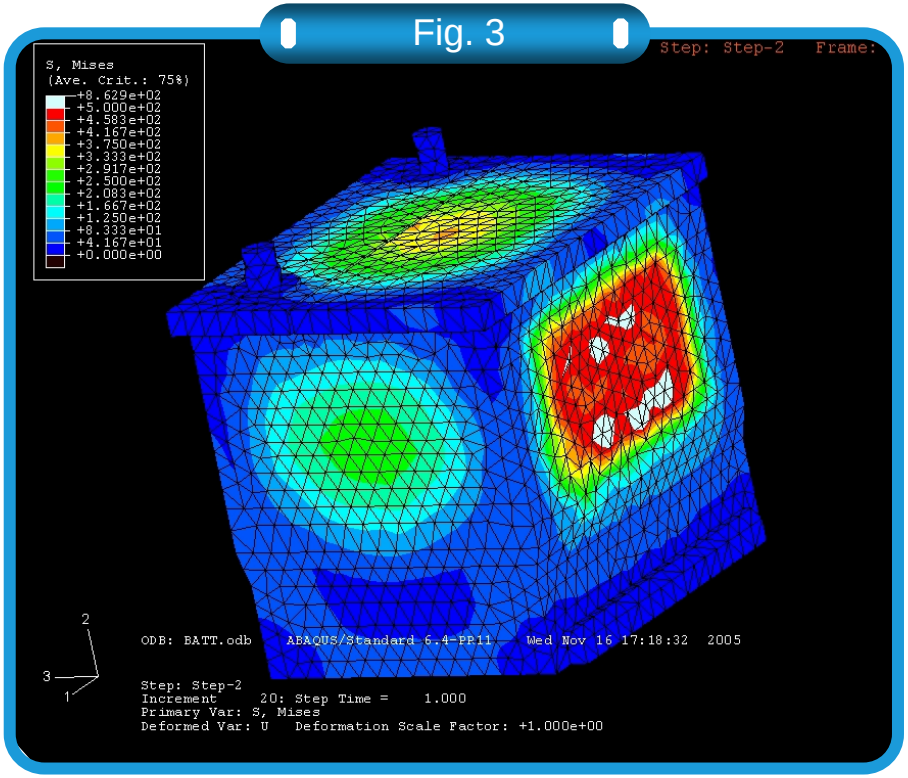
- 100000 N/m² = 10204 kg/m²
- Contact area is 0.18 x 0.09 x 2 = 0.0324 m², that is 330.6 kg.
- If vacuum plate is located at the side, contact area is fallen off to one fifth.
- So it can be 66.12kg. Compute inversely, there is 54439 N/m²
- difference between air pressure and vacuum pressure because of vacuum state in case of low vacuum state in front table, it can be 66.05kg.

UG model explanation

5. Distribution of power which works on the battery

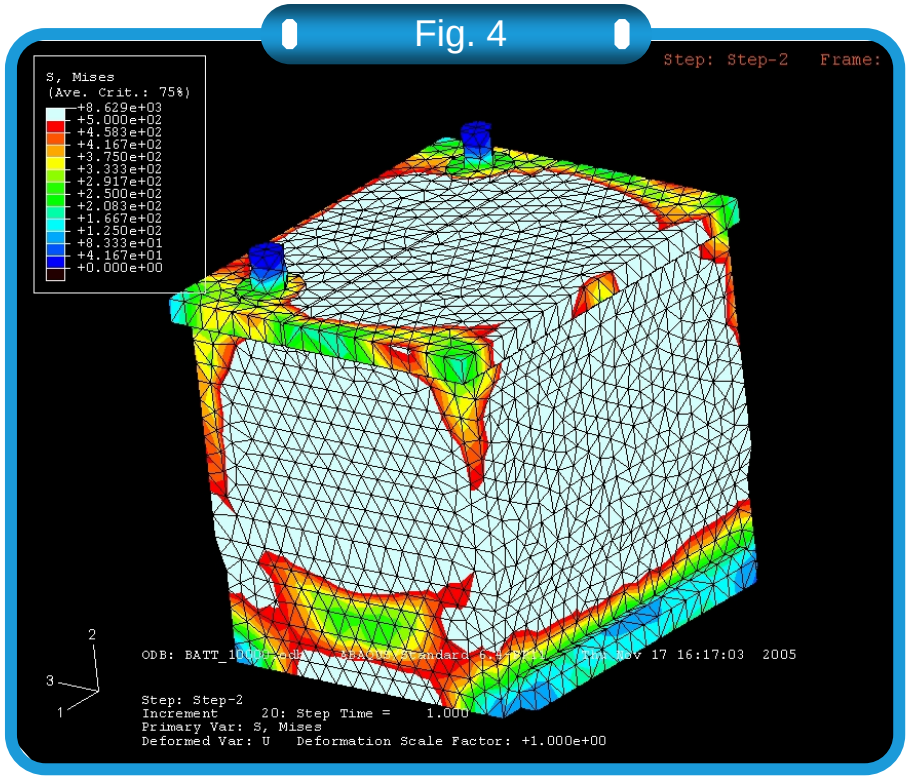
This analyzed the power that the battery took when clamps held the battery and made vacuous by ABAQUS software.

Fig. 3



The result of Using low air pressure

Fig. 4

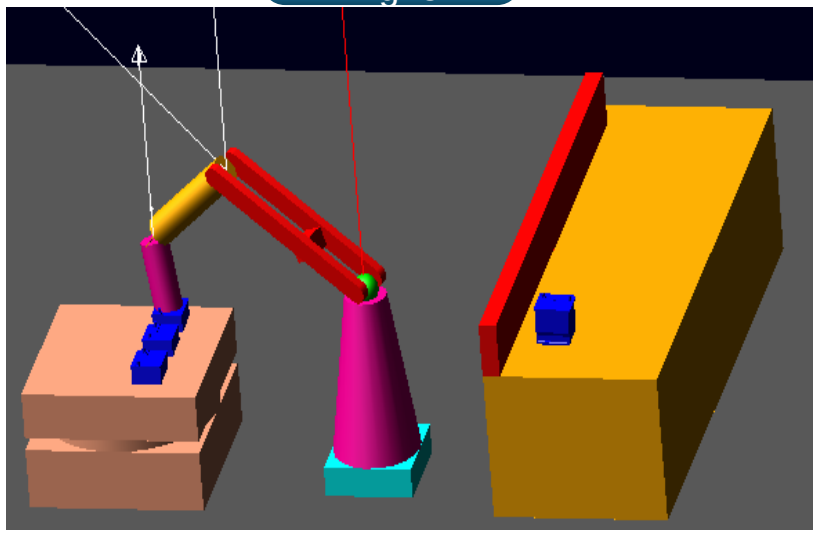


The result of Using high air pressure

UG model explanation

6. We got rough plan measure using digital model analysis program with MSC_Software ADAMS and at the same time we verified safety and efficiency through simulation

Fig. 5



7. Detail plan – Fig. 6~8

Fig. 6

Fig. 7

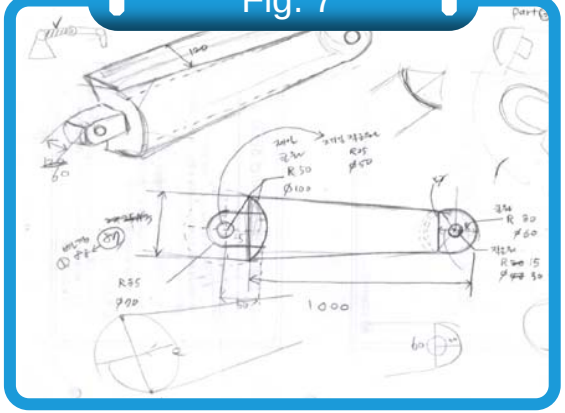
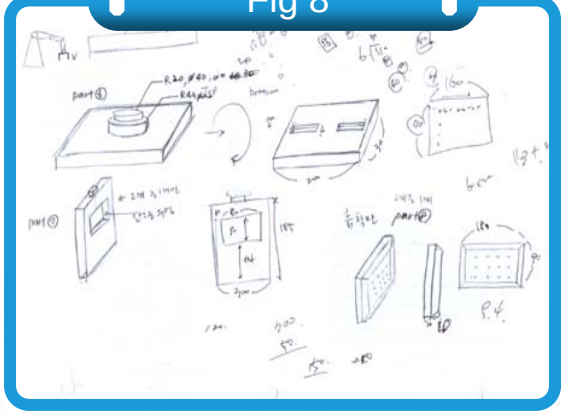


Fig 8



UG model explanation

8. Virtual model plan using UG

Fig. 9

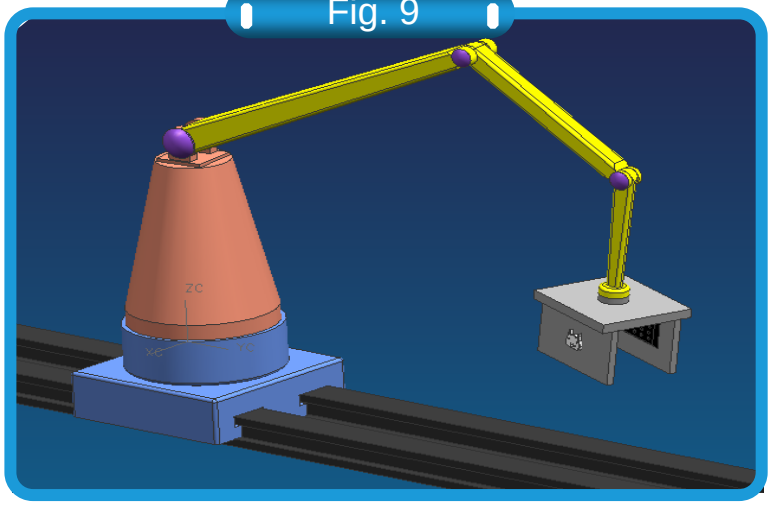
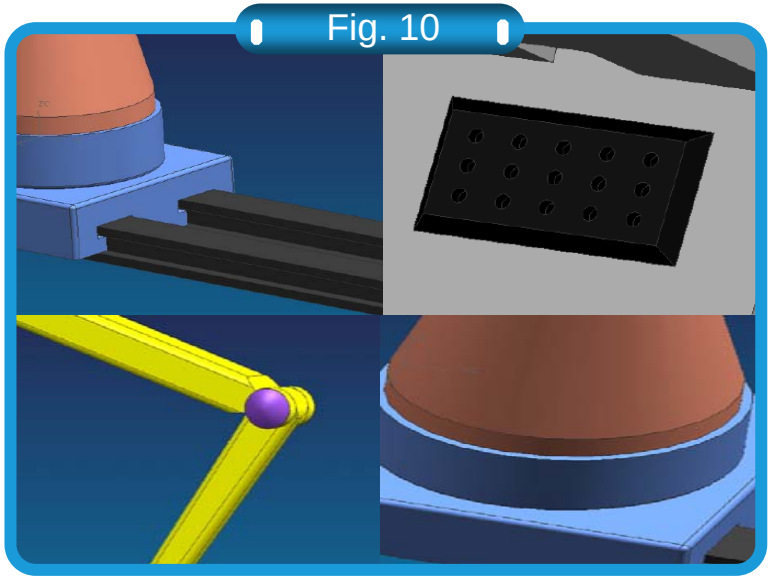


Fig. 10



Feature of UG model

① Whole automation system

② Lane setting considered with production line movement of factory

③ Arrange a number of fine inhalation hole at contacting part of clamps parts so that keep stabler inhalation power compared with single inhalation plate

④ Increase degree of freedom of robot's working space using body rotation and multi joints

⑤ Accurate measure deduction using kinetic analysis program ADAMS

⑥ Battery transportation cooperation device realization based on inhalation plate movement

⑦ Design robot for simple skill performance

Action explanation of designed device

Important part capture and explanation with picture using VisMockup

① Approach the battery and hold it.

② After holing it using clamps, fix the battery by inhalation power of air.

③ After lift the battery vertically, and spin it. And locate it at upside, where the battery would be located in actual vehicle.

④ When a vehicle go into its process, robot moves at same speed with vehicle and robot's arm move to assembling part of battery.

Fig. 11

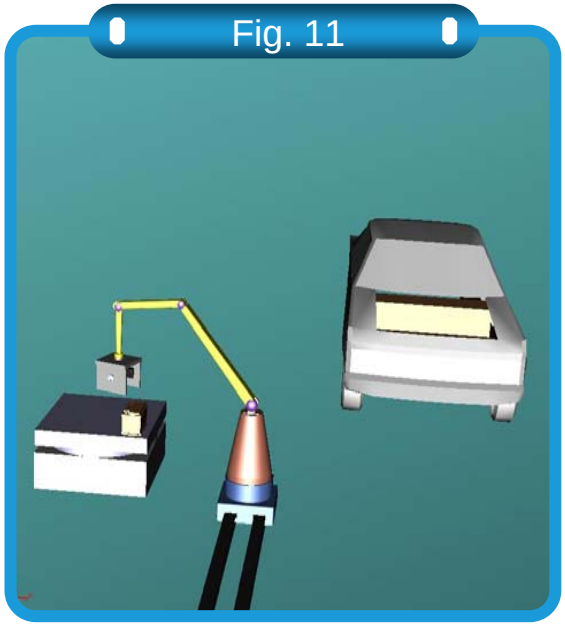


Fig. 12

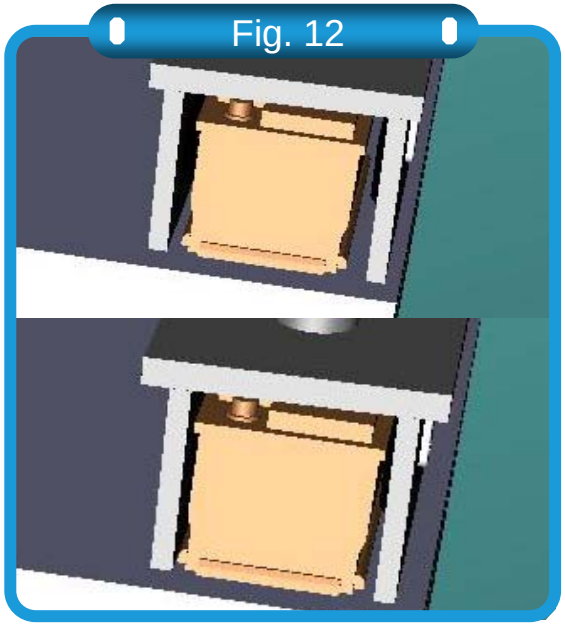
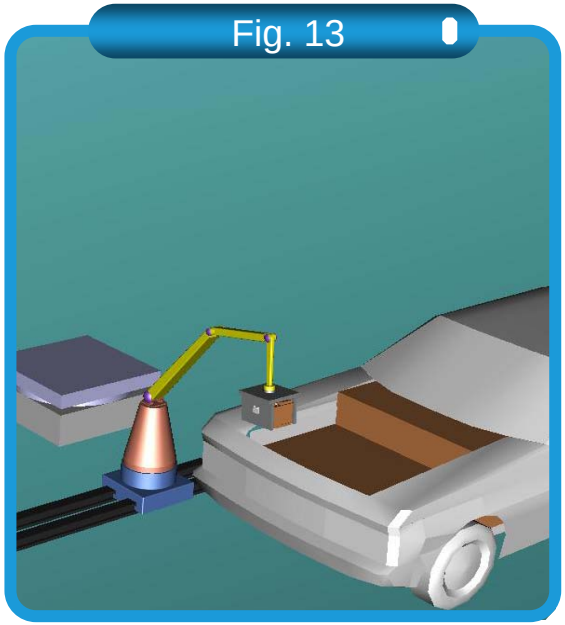


Fig. 13



Action explanation of designed device

Important part capture and explanation with picture using VisMockup

⑤ When robot's arm reaches assembling part, cancel vacuous condition and widen it's clamps. Vacuum plate should be angled diagonally for smooth separation of clamps .

⑥ The arm rise up to the upper part of vehicle and spin to the forward.

⑦ After the arm get removed from the transfer course of vehicle, robot moves to battery's position again.

Fig. 14

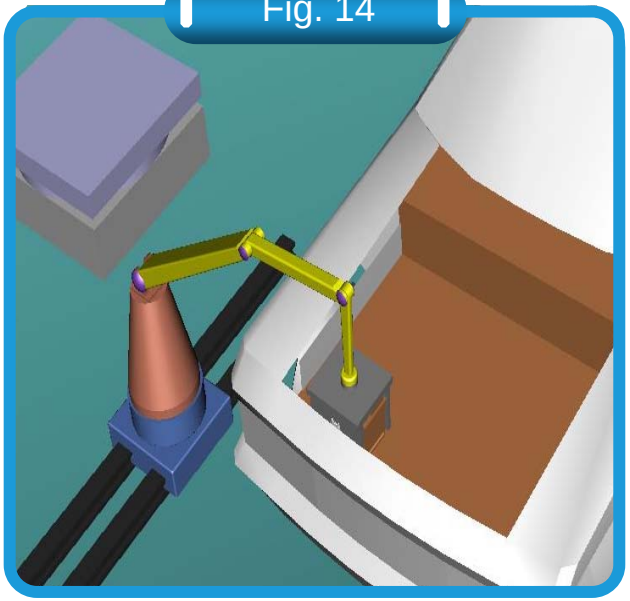


Fig. 15

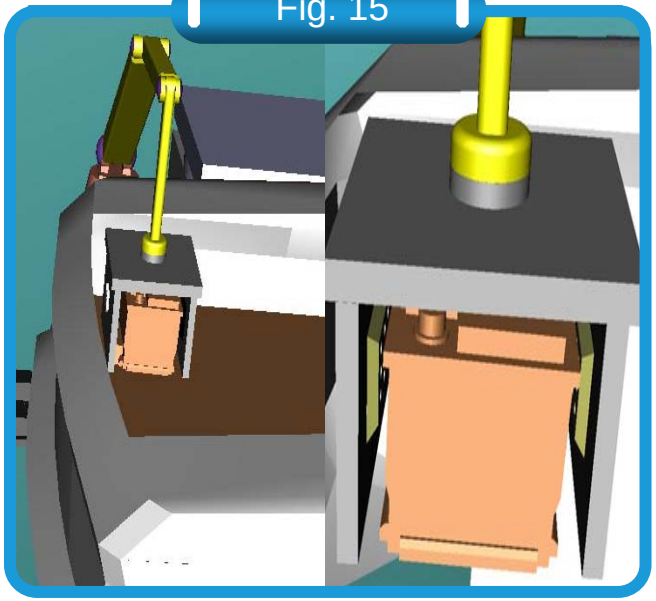
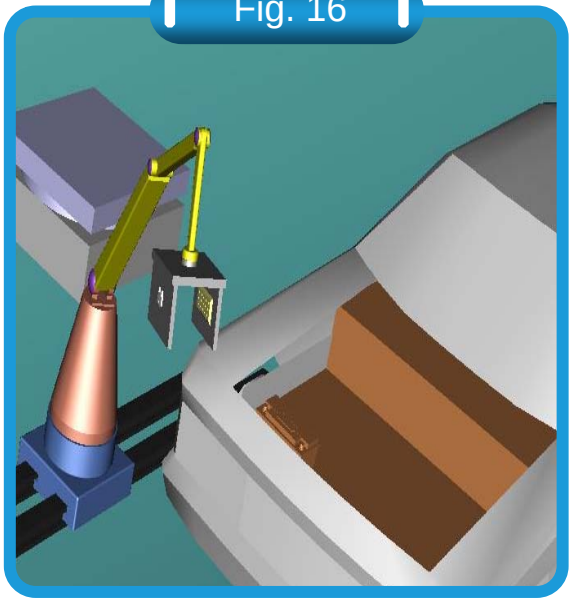


Fig. 16



Expected efficiency of new device

1. Expected efficiency

① Give rotation motion speed 110º/sec to robot's rotation part,
so it takes within 2 seconds for one rotation - increase productivity

② Use not just simple holding robot but also inhalation using vacuum
so that it fulfills accurate functions and reduces the number of inferior products.
→ 6-Sigma pursuit

③ Move robot and factory's current line at once
so that we can eliminate possible repose of line.

Expected efficiency of new device

2. Expectation effect and merits

Without loss

Increase efficiency of human resource system through electric automatic system (eliminate uncertainty of production by human's irregular work)

Prevent Industrial disaster

Prevent industrial disaster by preventing muscle skeletal disease. (according to the industrial safety corporation's statistical data, lifting work resulted in most problems in muscle and skeletal disease, so eliminate lifting work)

Increase safety

Use clamps using inhalation power so that increase safety.

Reduce Production cost

Simple design make workers can control and repair robots by themselves and reduce production cost.

Expected efficiency of new device

3. Demerits

① **Restriction** of working space because of rails on the floor.

② It is necessary to **use complex algorithm** for construction of automation system.

③ Increase **early investment cost** for using devices.

4. Conquest plan of demerits

① **Broaden working space** by make sufficient space at process.

② Make production process uniformly and eliminate variable possibility so you can **eliminate complexity of algorithm**.

③ **Saving the cost** of maintenance including personnel expenses and increase of productivity and efficiency make profit in a long run.