

Fixture for Free Return of Charging Device (FRCD)

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Abstract: The main aim of all kinds of circuit breaker is to prevent the reestablishment of arcing after current zero by creating a situation where in the contact gap will withstand the system recovery voltage. The air circuit breaker does the same but in different manner. For interrupting arc it creates an arc voltage in excess of the supply voltage. Arc voltage is defined as the minimum voltage required maintaining the arc. This circuit breaker increases the arc voltage by mainly three different ways: 1. It may increase the arc voltage by cooling the arc plasma. As the temperature of arc plasma is decreased, the mobility of the particle in arc plasma is reduced hence more voltage gradient is required to maintain the arc. 2. It may increase the arc voltage by lengthening the arc path. As the length of arc path is increased, the resistance of the path is increased, and hence to maintain the same arc current more voltage is required to be applied across the arc path. That means arc voltage is increased. 3. Splitting up the arc into a number of series arcs also increases the arc voltage.

Keywords: Circuit breaker, Free return of charging device, Crank assembly, Riveting, Fixture

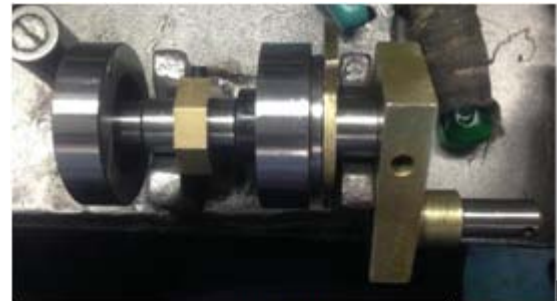
1. Introduction

FRCD (Free Return Charging Device) assembly is basically considered as the heart of an ACB. It is the most important part which helps in performing various operations in a breaker. It facilitates the functioning and movement of various components in an ACB. The handle on an ACB is connected to this component, during the charging the gap between nut and the plate goes on reducing, until the plate touches the nut, a "tick" sound is heard which indicates that the breaker is ready to start. On pushing the lever the breaker sets on and current starts flowing. Further due to overload the plate is pushed electrically as a result the contact is released and the current flow stops, thereby protecting other devices.



Free Return Charging Device

and bottom plate is fitted. Later the job is turned and a circular ring is inserted. Grease is applied to the components for effective functioning and to avoid friction between the components as the device is fitted in an Air circuit breaker. After which plain rollers are inserted, (for C-2 breakers 16 plain rollers and 3 cut rollers are used) a washer is inserted followed by 2 pins in bottom plate with 2 springs. Here on the job is turned and the top assembly is fitted and assembled with nuts, latch is attached with grease and bottom spring is connected to the latch. Further the screws are **damaged** so that a copy /replica is not made. The assembly is done manually in the following stages:



Stage 1



Stage 2

2. Literary Survey

The original assembly is dislocated as obtained from the vendor. It basically consists of 3 types low, medium and special. The medium ones are the one characterized by 3 punches on top of the assembly which are denoted as C-3. Initially the pins are removed and small pins are inserted into the assembly. Further the components are assembled



Stage 3



Stage 4

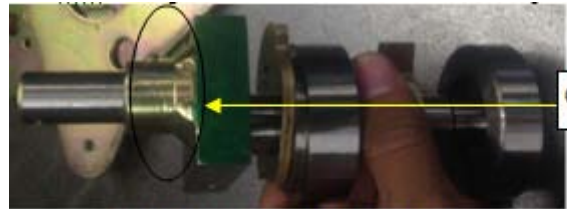


Stage 5



Complete Assembly

[NOTE: For a C-3 breaker of a higher range there is a need to use 6 cut rollers and 13 plain rollers, it is identified by punching 3 spots on top. There also exists a special kind of breaker in which the FRCD is denoted by green paint on its front side, it is manufactured as per the customer needs, here silver pins are inserted instead of black.]



Special case assembly of FRCD



FRCD with punching

3. Problem Definition

It was noticed in assembly line about sluggish movement of elements in FRCD assembly. Hence it was decided to analyze the problem and find the root cause for the defective FRCD. This was the main reason for which the project was undertaken.

4. Methods / Approach

Study was carried out and detailed analysis of the FRCD was done; the results highlighted that the Crank assembly which was used in the assembly of FRCD was found to be defective. A crank assembly is generally a combination of plates consisting of a pin and lever and the two plates (top and bottom) which are connected by riveting at one end. The following picture describes the problem:



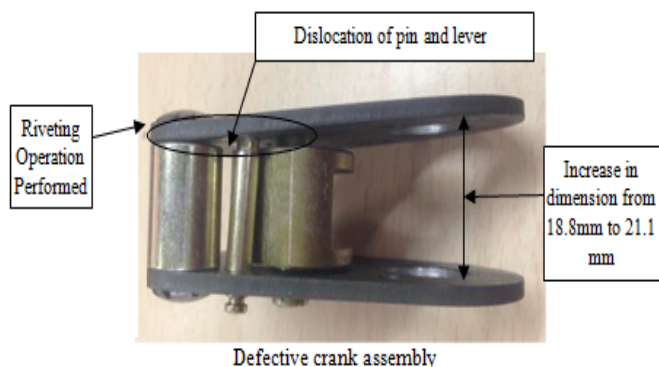
Misaligned

Crank Assembly

It was noticed that the gap between the upper and lower crank plate was not as per specifications. The problem occurred during riveting operation of the component. It was observed that the existing fixture does not have any arrangement to keep the top and bottom crank plates clamped together during riveting operation. This resulted in opening of top and bottom crank plates at non riveting end. As per the Blue print specifications the distance between the two plates should have been 18.8mm but due to the opening, the distance had increased to 21.1mm. Moreover even the pins and lever got misaligned when riveting was done causing a lot of rejections.

As seen in the figure above the Crank assembly in the FRCD was misaligned at its one end. This caused the crank assembly to shift from its symmetrical position (axis) thereby causing sluggish movement in the FRCD as all the other elements in FRCD are connected to this Crank. The existing fixture did not have any provision to eliminate this problem; hence there existed a need to develop a new fixture.

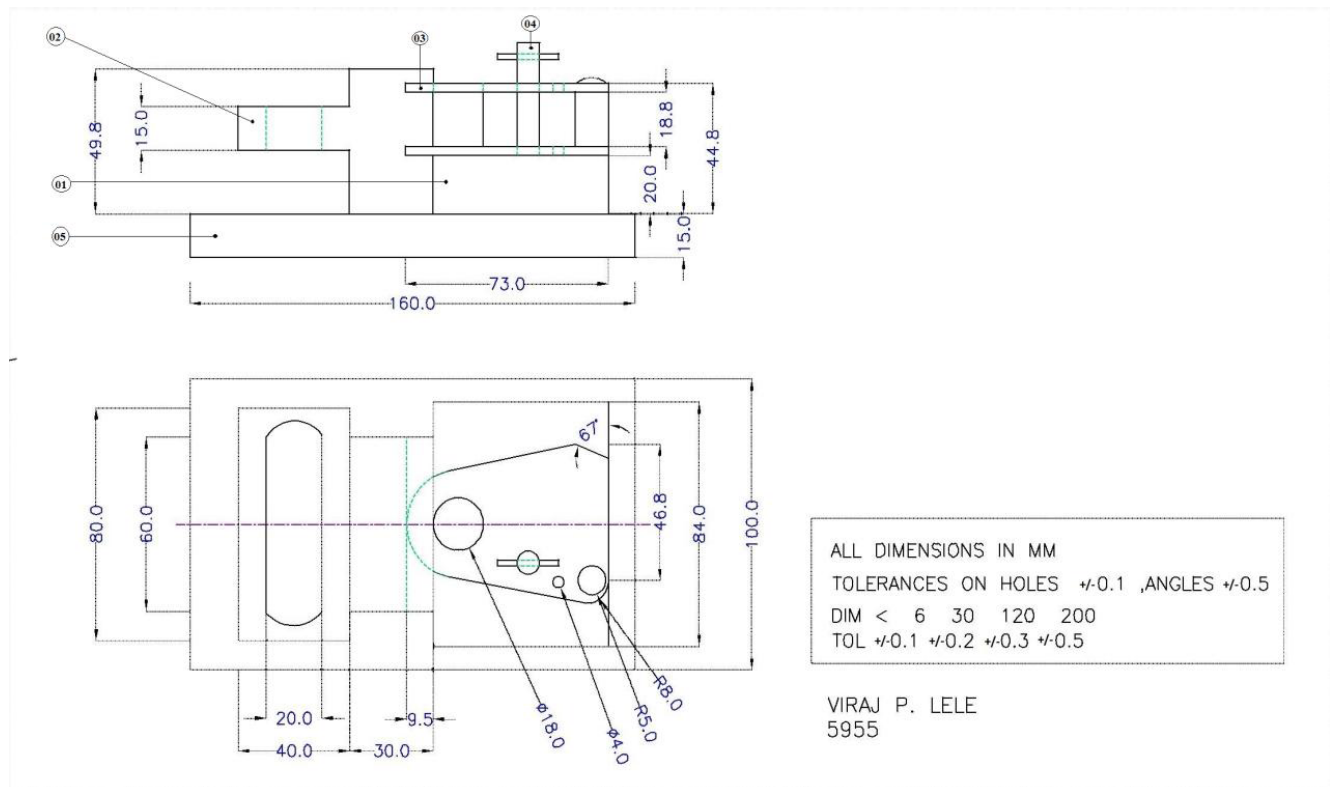
Proper analysis of the current fixture was done which stated that; nowhere in the fixture was there an arrangement which would prevent the opening of the plates of crank assembly when riveting operation was performed and this even resulted in the dislocation of pin and lever inside the assembly.



Old fixture

Scope existed in designing of a new fixture which would prevent the opening up of the plates by supporting the plates at the non riveting end so that they are held firmly when riveting operation is performed. This would prevent opening at the non riveting end. The design of fixture was made such that even the problem of dislocation of pin and lever was taken care of. At the same time the strength of crank plates was checked so that they effectively withstand the riveting forces when inserted into the new design. All the observations gave favourable results that led to the designing and approval of the new fixture. The following measures were taken in designing of the new fixture:

1. Taking a note of the crank plates; the base of the fixture was increased to 160mm unlike the earlier 130mm as shown in fig. below.
2. Handle arrangement was provided with a slot of 20mm wide and 15mm deep which could be easily moved and adjusted by hand. Shown in fig. below.
3. A pin was designed which would enter the crank assembly from the top keeping the pin and lever intact in its position as shown in the fig. below.
4. The width of the base plate was reduced from 150mm to 100mm as the space earlier was just wasted thereby reducing weight.
5. For effective entering of the handle; a gap was created between the bottom plate of crank assembly and the fixture plate by reducing the fixture plate length from 75mm to 70mm.



New fixture design

5	BASE PLATE	1	160×100×15	CI
4	PIN	1	Ø8×40	MS
3	CRANK ASSEMBLY	1	54.8×73×22.8	LOW ALLOY STEEL
2	HANDLE	1	80×70×49.9	MS
1	FIXTURE PLATE	1	63.5×84×20	CI
PART NO.	DESCRIPTION	QTY.	DIMENSION	MATERIAL

Bill of Materials

5. Results/ Discussions

Operator now has to place the lower crank plate on the fixture, place the pin and lever in the slot, place the top crank plate, attach spring at the top to hold the lever and with the help of the handle assembly slide it in such that it enters the gap between the crank assembly and fixture plate thereby locking the crank plates at the non riveting end and insert the pin from the top and carry out the riveting operation.

This prevented opening of the plates at non riveting end as the plates are firmly held by the handle assembly when riveting starts. The pin which is inserted from top also prevents dislocation of the inner components as discussed earlier. Because of the new fixture a proper blue print dimension of **18.8mm** between the crank plates was obtained and even the problem of dislocation was prevented. Moreover unlike earlier where one assembly took **30seconds**, the current fixture reduces the cycle time to **20 seconds**.

Once riveting is done the operator has to withdraw (take back) the handle assembly and remove the crank from the fixture; this reduces operator fatigue which also was a problem in the old fixture. As this fixture is light in weight it

can easily be carried to different riveting machines thereby not limiting its use only on one machine.



Desired assembly

6. Conclusion

Thus the proposed new fixture eliminated all the above factors responsible for opening of the crank plates and dislocation of pin and lever inside the assembly and at the same time even benefitted the company with Rs. 1lac. The project is currently implemented by the company and the production of crank plates and FRCD is even facilitated hereon.

7. Future Scope

Scope of improvement does surely exist in every case and this project is no exception to the same. Modifications are possible which involves designing of a side strip with a flange nut in the crank assembly fixture which would prevent the opening of the plates at the non-riveting end, this would however make the design complicated but the purpose will be solved.

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Author Profile



Viraj P. Lele, Bachelor of Production Engineering and a Gold medallist of the University of Mumbai in Production Engineering for the academic year 2013-2014. Graduated as Production Engineer from Fr. Conceicao Rodrigues College of Engineering Bandra (West), Mumbai and was an implant trainee at 'Larsen and Toubro Limited' EAIC department where the above project was carried out.