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Manufacture and Application of 50kVA 380/220V Kincir Generator Protection System.

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Abstract

Generators and motors in their operations at any time can experience short circuit or overcurrent interference, where the short circuit current can occur due to a short connection between the phase wire and the ground or with a neutral wire, this short circuit current is very large and must be interrupted immediately, otherwise the generator or motor can be burned or damaged, where over current can occur because the generator or motor is forced to operate exceed its nominal load, and if the generator or motor continues to be allowed to operate in an overload condition, then the generator or motor will be heat and damaged, short circuit current or over current must be immediately interrupted so that the generator or motor is not damaged, to break the current, it is necessary to make a breaker or a large size protection device adjusted to the generator or motor that wants to be protected, to make a protective device, a set of protective devices is needed, namely current transformers for protection, overcurrent relays, magnetic breakers, pilot lights, connecting cables, cable terminals, panel boxes and support poles, these tools are assembled in a panel box so that they become a unit of protection, so that a protection device is produced in the form of one panel box that easily attaches it to the generator or motor, this protective device is made to meet the needs of the waterwheel generator in a village of Desa Suka Dame, with the existence of this protection tool, the villagers can keep their waterwheel generator protected from damage, due to a short circuit or overload, the waterwheel generator they have can be better maintenance.

Keywords: overcurrent relays, current transformers, circuit breakers

1.1 Background

The Kincir Generator is a generator whose drive is a waterwheel, this generator is widely available in villages adjacent to the river and located far from the city and has not received electricity from PLN. This waterwheel generator can experience interference in its operation, both from the generator itself and from outside the generator. The easiest disruption is a single phase to ground short circuit or a short circuit between a phase wire and a neutral wire, if this happens then a very large current will flow in the generator coil and this large current will cause a large amount of heat and burn the insulation of the generator coil and the coil wire will also melt. In addition to one phase to neutral short circuit, the most frequent interference experienced by a generator is overload interference. This overload disruption is the generator serving the load beyond the ability of the generator itself,and if this overload is left unchecked then the generator coil will experience excessive heat, and can make the generator coil insulation burn or at least reduce the life of the generator. So that the generator is not burned or does not experience damage due to a short circuit between phase wire and neutral wire, or the occurrence of excessive loading on the generator, can be done by installing over current relay protection equipment or Over Current Relay Protection on the generator output side. The protective equipment installed is adjusted to the capacity of the waterwheel generator in the village of Desa Suka Dame, where the generator capacity is 50 KVA 380/220 V, then the ability of the protection device must be able to disconnect a current of 75 Ampere and greater.

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1.2 Formulation of the Problem

This study tried to design a Kincir Generator 50 KVA 380/220 V protection device from short circuit current or over current. This protection device is able to secure the generator from damage due to a short circuit between the phase wire and neutral wire or when the generator has excessive load. This built-in protection device is designed or equipped with protective aids, namely: three current transformers, over current relays, three phase magnetic breaker, two pilot lights, connecting cables, panel box and supporting pole panel box. The panel box is needed as a box where the protective aids are installed. Each phase current coming out of the three generator terminals is passed through the three primary coil current transformers, the transformer secondary terminal of each current is connected to the over current relay coil terminal which is adjusted according to the phase sequence, then a closed circuit is made where the AC 220 V source from the generator downstream of the magnetic breaker is connected to the over current relay contact which is NC (Normally Close) and to the magnetic breaker coil terminal.

1.3 Scope of the Problem

This research is only focused on the manufacture of a 50 kva 380/220 v waterwheel generator protection device from short circuit and over current interference. Current transformer ratings are limited to 75/5 A, maximum over current relay input of 5 A, magnetic breaker capacity is limited to no more than 100 A, panel box size is 60 x 40 x 20 cm, height of panel box support is 1.5 m, panel box equipped with 2 pilot lights to determine the status of the protection device whether it is ON or OFF.

1.4 Research Purposes

The research oectives are:
1. To make a short-circuit current or over current protection device for the waterwheel generator in village Desa Suka Dame
2. To get a protective device that has the ability reliable in interrupted short circuit current or over current so that the generator is kept safe
3. To be an analytical study and comparative study for Engineering students Energy Conversion Department of Mechanical Engineering, Medan State Polytechnic at Laboratorium Energy Conversion Technique.

2.0 Theoretical Basis

Current Transformer (CT)

Current Transformer (CT) is an equipment used to measure the amount of current in the installation of electric power on the primary side of a large scale, by transforming from a large current to a small amount of current accurately and accurately for measurement and protection purposes[3)].
The current transformer aims to convert the primary current which has a large current value into a secondary current which has a low value of 1A or 5A, depending on the application needed.
Because it aims to convert the current, then on both sides of the current transformer a closed circuit must be formed so that the flow of current is possible.
In other words, on the primary side the current transformer must be installed in series with the load and on the secondary side the current transformer must be connected to the load of the measuring equipment or protection equipment.

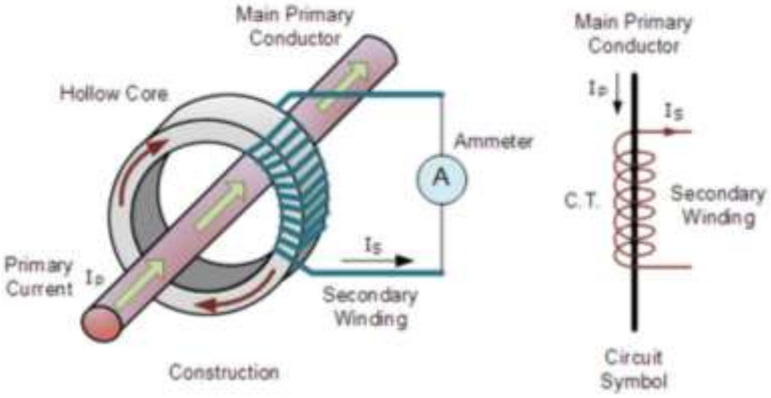

Figure 2.1. Current transformer (CT) with secondary connected to ampere mete

2.1 Fundamental of current transformer

When the primary current Ip flows on the primary winding, the magnetic field will appear around the primary winding. The magnetic field will accumulate more in the core or core. Magnetic fields that rotate inside the core or core produce changes in the primary flux and cut the secondary windings so as to induce stresses on the secondary winding according to Faraday's law. Because the secondary windings form a closed loop, a secondary current will flow, which will generate a magnetic field to counteract the magnetic flux generated by the primary winding according to Lenz's law.

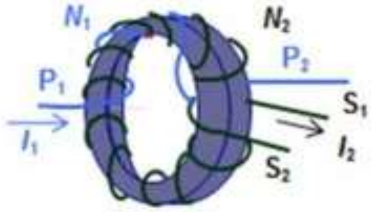

Figure 2.2. Current Transformer (CT) circuit

For transformers that are short-circuited:

$$I_1 \cdot N_1 = I_2 \cdot N_2$$

For transformers under no-load conditions:

$$\frac{E_1}{E_2} = \frac{N_1}{N_2}$$

Equivalent circuit:

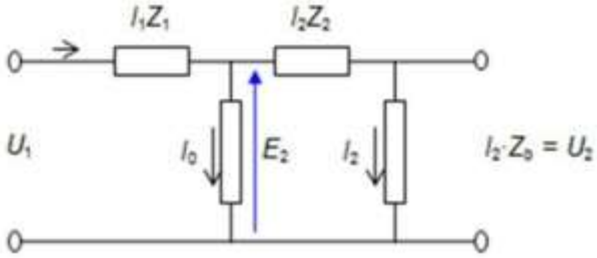

Figure 2.3. Equivalent Circuit of Current Transformers

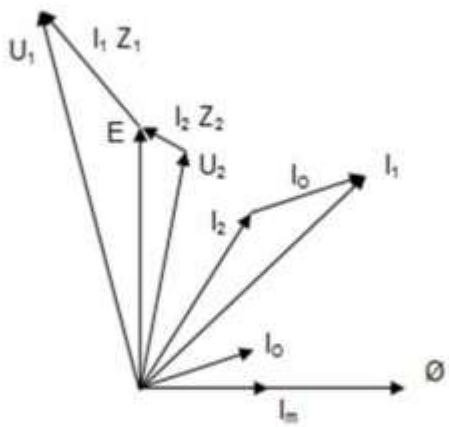

Figure 2.4. Phasor diagram of current and voltage on current transformers

2.2 Overcurrent Relay

Over current relays are relays that work based on a current increase that exceeds a certain safety value and a certain period of time. The main function of this overcurrent relay is to sense the presence of overcurrent and then give an order to the circuit breaker (CB) to open. Basically the overcurrent relay is a device that detects the amount of current through a network with the help of a current transformer. The maximum current allowed to pass through the relay is called the current relay setting. Overcurrent relays work by reading the input in the form of a current magnitude then comparing it to the setting value, if the current value read by the relay exceeds the setting value, the relay will send the trip command to the Circuit Breaker after the time delay applied to setting.

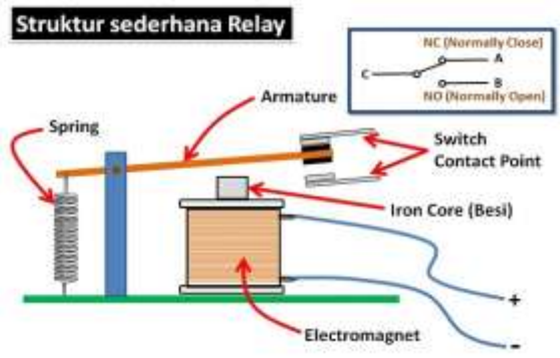

Figure 2.5. Simple Relay Structure

Over Current Relay is divided into 3 types:
a. Instantaneous Over Current Relay
b. Definite time relay
c. Inverse Relay

a. Instantaneous Over Current Relay:
Relays that work instantly without delay time, when the current that flows exceeds the setting value, the relay will work in a few milliseconds (10-20 ms). We can see in the picture below

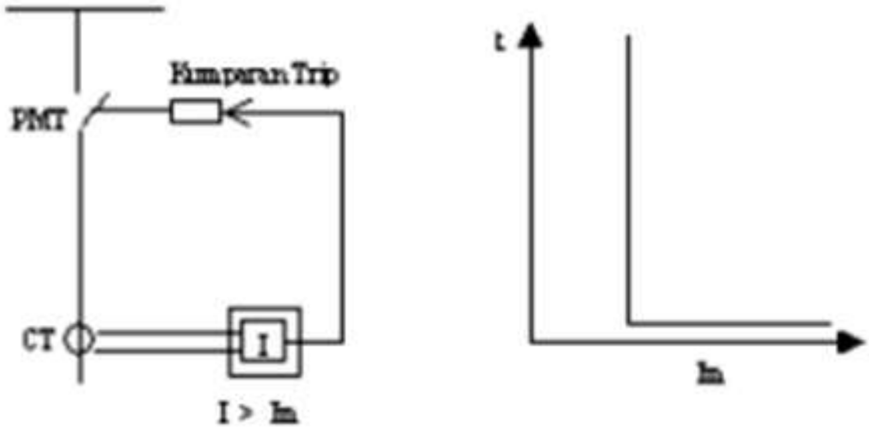

Figure 2.6. Characteristics of Instantaneous Over Current Relay

b. Definite time relay

This relay will give an order to the circuit breaker in the event of a short circuit and the amount of fault current exceeds the setting (Is), and the period of time the relay starts to pick up until the relay work is extended to a certain time not depending on the amount of current that is relaying, see the picture below.

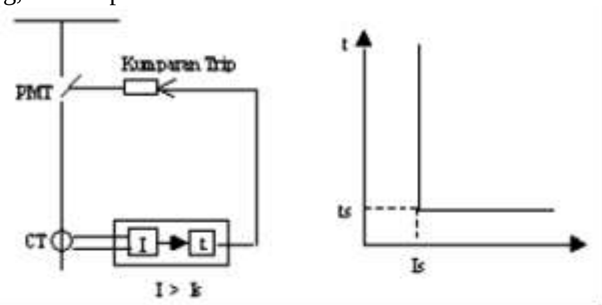

Figure 2.7 Characteristics of Definite Time Relay

c. Inverse Relay:

This relay will work with a delay that depends on the amount of current in inverse time, the greater the current, the smaller the delay time.

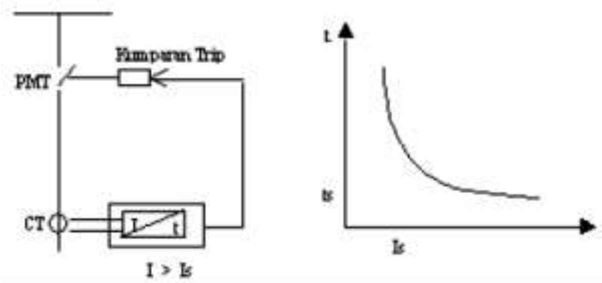

Figure 2.8. Characteristics of Inverse Relay.

2.3 Magnetic Contactor

Magnetic Contactor (MC) is a component that functions as a breaker and connecting contacts with a large capacity using minimal power. Can be considered a magnetic contactor is a relay with a large capacity. Generally magnetic contactors consist of 3 main contact poles and auxiliary contacts. To connect the main contact is done only by giving voltage to the magnetic contactor coil according to the specifications. The main component of a magnetic contactor is the main coil and contact. Coils are used to produce a magnetic field that will attract the main contact so that it is connected to each pole. And the contact will open when the voltage to the coil is disconnected.

Basic principles:

A contactor consists of a coil, several contacts Normally Open and Normally Close. When the contactor is normal, NO will open and when the contactor is working, NO will close. Whereas the reverse NC contact is that when in normal circumstances the NC contact will close and in the working state the NC contact will open. Coils are windings that when given a voltage magnetization will occur and pull the contacts so that changes or work occur. Electromagnetically operated contactors are one of the most useful mechanisms ever designed for the closure and opening of electrical circuits.

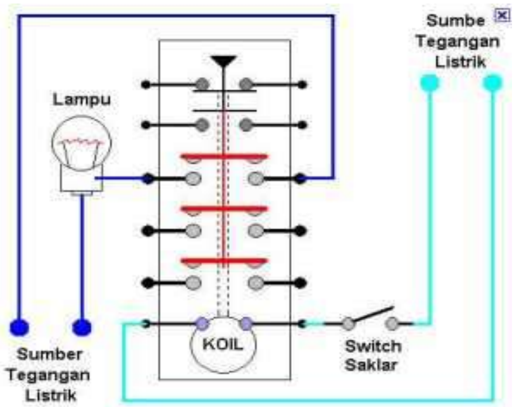

Figure 2.10. Circuit of Magnetic contactors

3.0 Discussion

Current transformers and over current relays that will be installed in this protection device need to be tested first, to find out their performance in accordance with the capacity of the wheel generator that the protection device will install.
Windmill generator 50 KVA 380 V / 220 V
The nominal current of the generator: 75 A
Current transformer: 75/5 A or current transformer ratio: 15: 1

A. Circuit and current transformer testing data

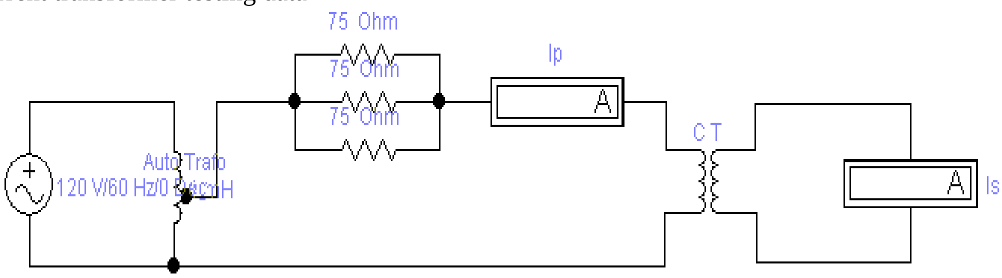

Figure 3.1. Current Transformer Test Series 75/5 A

Test results data

No	Ip (A)	Is (A)
1	4	0.20
2	6	0.30
3	8	0.45
4	10	0.60
5	12	0.75
6	14	0.80
7	16	0.95
8	18	1.10
9	20	1.25
10	22	1.45
11	24	1.60

From the test data shows that the current transformer works according to the comparison Ip / Is (15/1)

B. Circuit and over current relay testing data
The over current relay tested is the relay whose input current to the relay is set to 5 A

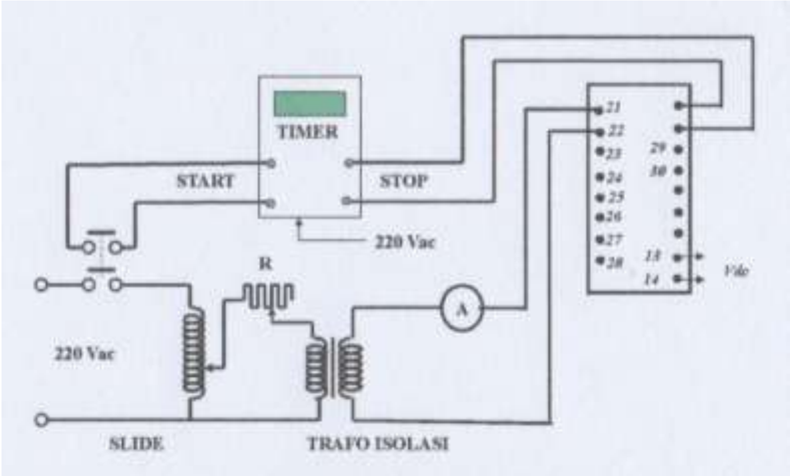

Figure 3.2 Circuit testing of overcurrent relays

Figure 3.3. Trial simulation of protection devices that have been made

Data from testing overcurrent relays

No	Relay Current (A)	Time Delay (s)	Over Time (s)	Time Trip (s)
1	1	0.5	0.3	No trip
2	2	0.5	0.3	No trip
3	3	0.5	0.3	No trip
4	4	0.5	0.3	No trip
5	4.9	0.5	0.3	No trip
6	5.1	0.5	0.3	0.8
7	5.1	1	1	2.1
8	5.1	2	2	3.9
9	5.1	3	3	5.9
10	5.1	4	4	7.9
11	5.1	5	5	9.9
12	5.1	10	6	16
13	5.1	20	7	17
14	5.5	10	1	11
15	6	10	1	11
16	7	10	1	11
17	8	10	1	11
18	9	10	1	11
19	10	10	1	11

Figure 3.4. Protection device that is ready to be installed

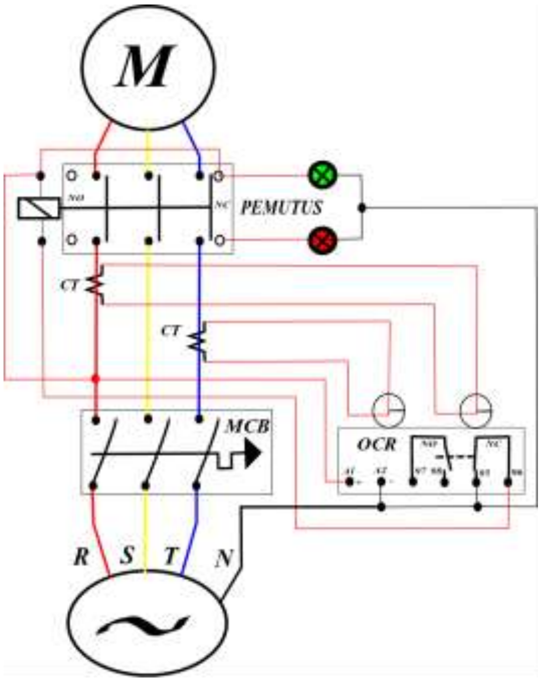

Figure 3.5. Circuit of protective devices that will be installed on the waterwheel generator

Phase currents flowing to the load are passed through the primary transformer current coil, namely as a current transformer input, and the transformer current secondary coil is the current transformer output connected to the input of the Overcurrent Relay. Under normal circumstances where there is no interference or no overload or short circuit phase, the over current relay does not work and the magnetic contactor still closes because the magnetic coil (tripping coil) gets voltage from the source, but if there is overcurrent due to overloading or short circuit current occurs due to a short circuit in the phase wire, which makes the current entering the relay exceeds the setting current, the overcurrent relay will work or trip to break the current to the magnetic coil (tripping coil), so the magnetic contactor will open to disconnect the current to load, thus the protected waterwheel generator remains safe.

4.0 Conclusion

1. If the current flows to the relay are smaller than the current setting the relay does not trip.
2. Over current relays will trip when the current to the relay is greater than the current setting.
3. The relay trip time does not depend on the size of the relay current.
4. The magnetic breaker will open when the relay trips.

References

Andri Tukananto, Design of a Flow Protection System for Over 3 Phase Motors With Timer Start and Trip, Research Journal, 2015

Ahmad Ridwan, Design of Three Phase Induction Motor Protection SystemAgainst Microcontroller-Based Flow Disorders, Research Journal, 2015

Bonar Panjaitan, Electric Power System Protection Practices, Andi Yogyakarta 2012

Lutfi Lastiko Wibowo, Ir.Agung Warsito, DHET., Current And Transformer Maintenance of Current Transformers in Pt. Pln (Persero) P3b Java Region Central & Diy Semarang Upt, Gis 150kv Simpang Lima, Engineering Department Electro, Faculty of Engineering, Diponegoro University, 2011Email: upekstifler@gmail.com

Muhalan, Budi Yanto Husodo, Calculation Analysis and Flow Relay Settings More and Soil Disturbance Relays on 20 KV Chakra Cubicles at PT XYZ Electrical Engineering Study Program, Faculty of Engineering, Mercu Buana University Jakarta, 2008 Email: husodo2008@gmail.com

Muhammad Taqiyyuddin Alawiy, Electric Power System Protection, Relay Series Elektromagnetis, FTE UIM 2006

Natalis Hengky Richardo, Junaidi, Ayong Hiendro, System Design Overcurrent Protection of Three-Phase-Based Induction Motor, Microcontroller Atmega16, Electrical Engineering Study Program, Faculty of Electrical Engineering Department Engineering of Tanjungpura University, 2017 Email: hengkyricardo0699@gmail.com

Ramadoni Syahputra, Test of Characteristics of Device-Based Current Transformers Emtp Software (Characteristic Test of Current Transformer Based EMTP Software), Department of Electrical Engineering, Faculty of Engineering, Muhammadiyah University Yogyakarta, Jl. West Ringroad, Tamantirto, Kasihan, Yogyakarta 55183 E-mail: ramadoni@umy.ac.id

Tiyono, Designing Relay Settings for Overcurrent Protection on Electric Motors Industry, Department of Electrical Engineering and Information Technology, Faculty of Engineering, Gadjah Mada University Yogyakarta, 2016 email: tiyono@te.ugm.ac.id

BlogListrik.com Encyclopedia of Electric Power Systems http://www.bloglistrik.com/2016/08/trafo-arus-ct.html?m=1

https://electricing.wordpress.com/2011/07/11/contactor-magnetic- magnetic-contactor-mc /

https://anggerrose.wordpress.com/2012/05/08/relai-arus-lebih/