COOLING SYSTEM FOR MECHANICAL RECTIFIER CONTACTS

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My invention relates to a cooling system for cooling of contacts of a mechanical rectifier, and more specifically to a cooling system in which the members coming into contact with the cooling air have a metallic lining which will absorb chemical impurities in the cooling air which are combiner with the mechanical rectifier contact material.

A mechanical rectifier is a mechanically operated switch which works in conjunction with commutating machines. The switch or contact is usually of the type having a pair of stationary contacts and contact engagement and disengagement is then effected by a bridging contact. Contacts of the type used in mechanical rectifiers are clearly shown in co-pending application Serial No. 307,067 filed August 25, 1922, and assigned to the assignee of the present invention, now Patent No. 2,798,909. The commutating reactor which is placed in series with the contact is of the type shown in U. S. Patent No. 2,693,569 assigned to the assignee of the instant application, and is used to provide a low current step in which the contact may be engaged or disengaged. Details of mechanical rectifier operation and the operation of the contacts in conjunction with the commutating reactors is clearly described in both of the above mentioned cases.

In order to obtain the switching of large currents at a high repetition rate with accuracy and without damage to the parts involved, the moving conductors of the contact such as the bridging contact are made very small. Therefore the current density in the contact material attains values of 15,000 to 20,000 amperes per square inch. This current density is more than ten times higher than the current density used in other electrical conductors such as the A-C. bus and D-C. bus which are synchronously connected by the above mentioned bridging contact. This high current density together with the appreciable resistance of the contact points between the movable conductors and the fixed conductors of the switch mechanism cause an appreciable amount of heat within a relatively small volume.

For instance, in a practical contact there is approximately two hundred watts per cubic inch of material. The fixed conductors which are the A-C. and D-C. bus leading to the contact mechanism are of very large cross-section which can be as much as forty to fifty times the cross-section of the movable or bridging contact and permit an easy heat flow away from the small concentrated heat source by conduction. However, the problem still remains to cool these large volume fixed conductors to a relatively low temperature to thereby assure that the actual contact pieces will not get too hot.

The operation of contact elements under high temperature offers many disadvantages. The first disadvantage would be that the unequal expansion due to heat of the metallic bus structure which can be of copper, the insulators which can be of porcelain, and the frame which can be of steel and fasteners which can be steel bolts, as compared to the length of the operation push rods which are usually constructed of steel and static, cause an appreciable difference in contact timing and therefore interfere with the electrical operation. If, for instance, there is only $V_{H_{00}}$ of an inch expansion difference in the above mentioned elements, the contact timing would be changed by 1% electrical degrees.

A second disadvantage of contacts running under high temperature is that the excessive heat will cause deterioration of springs which are used to bias the movable contact to the engaged position.

A third disadvantage is that metallic contacts working at high velocity impact are subjected to high stresses. Furthermore, since they work at a high repetition rate which would be 216,000 operations per hour when rectifying a sixty-cycle source, the high stresses at this high repetition rate promotes serious mechanical wear. Practical experience has shown that this mechanical wear increases tremendously when the temperature of the contacts exceed approximately 105°F.

Electrical contacts also present problems which are not connected with heat but are caused by contact operation in a corrosive atmosphere. Contacts are metallic bodies which are separated by a layer of gas or air when they are opened and directly touching when closed. The active surface of the contacts is therefore alternately submitted to the influence of the atmosphere and the action of a strong electric current flowing across this surface from one body to another.

Since practical contacts are made of pure silver or alloy containing silver, such as silver-nickel, silver-copper, they are very little affected by pure air or pure air containing humidity. However, traces of sulphur, chlorine or their compounds such as H₂S, SO₃, HCl, HClO₄ are extremely harmful. Furthermore, corrosive or insulating dust creates a similar problem to that of the above mentioned chemical corrosion.

As mentioned above, cooling of the contacts is essential but cooling the contacts of a mechanical rectifier mechanism requires tons of air per day and it is obvious that if this amount of air is permitted to come in direct contact with the active contact surfaces, a minute fraction of a percent of the above mentioned dangerous compounds in the air will be extremely detrimental to the contact life.

The principle of my invention is to line the internal surfaces of an air duct or cooling coil which are responsible for carrying or circulating the cooling air with a metallic substance which will absorb the above noted chemical compounds which, if left in the air, would be absorbed by the contact surfaces.

By way of example, the cooling duct or cooling coil in the cooling system could be lined with copper if the cooling air has a substantial amount of hydrogen sulphide therein. Hence, the copper lining which presents a substantially large surface to the cooling air would absorb substantially all of the hydrogen sulphide before it is impinged upon the contact surfaces.

Accordingly, a primary object of my invention is to provide a circulating system for cooling mechanical rectifier contacts in which the circulated air comes into contact with a relatively large surface of material which will absorb gases or vapors which would be absorbed by the contact material.

Another object of my invention is to provide a circulating system for mechanical rectifiers which includes a circulating means, air conducting ducts and cooling coils wherein the inner surface of the cooling coil, conducting duct or any other body within the cooling system is sprayed with a metal that will chemically react with impurities in the circulating air that would be absorbed by the rectifier contacts.

Another object of my invention is to provide a cooling system for mechanical rectifiers which works in an at-
mosphere contaminated with hydrogen sulphide wherein internal portions of the cooling system are sprayed with copper which will thereby react with the hydrogen sulphide upon the cooperating contacts of the rectifier.

These and many other objects of my invention will become apparent from the following description taken in connection with the figures in which:

Figure 2 is a perspective view of a pair of mechanical rectifier contacts with an operating mechanism therefor, in which my novel cooling system is applied thereto.

In Figure 1 the source of alternating current is derived from an A-C voltage source which energizes the conductors 10 and passes through the circuit breakers 11 to the step down transformer 12. The current is subsequently passed through commutating reactors 13 to step the current for commutating purposes as set forth in U. S. Patent No. 2,993,569 assigned to the assignee of the instant application. The construction of the commutating reactor is described in co-pending application Serial No. 301,880 filed July 31, 1952, and assigned to the assignee of the instant application, now Patent No. 2,759,128.

The current then passes through the disconnecting switches 14 to the contact assemblies 15 and 16 which form the subject matter of the instant application. The contact assemblies 15 and 16, which are sequentially operated in synchronism with the frequency of the source, are connected to the alternating source buses A, B and C to the direct current load buses 20 and 25.

For purposes of simplification, I have shown in Figure 2 the mechanical switching arrangement which is utilized for phase A of Figure 1, it being understood that the switching apparatus for phases B and C are identical in construction.

A synchronous motor 48 drives the shaft 51 which in turn operates the eccentric member 43 to thereby alternately drive the push rods 46 and 47 upwardly through the bell cranks 44. A detailed explanation of the construction of the adjustment and control by means 48 is set forth in co-pending application Serial No. 307,024 filed Aug. 29, 1952.

The upward movement of the push rod 47 will urge the disc shaped bridging contact 31 upward against the bias of the helical spring 49 and thereby disengage it from engagement with the stationary A-C contact 28 and the positive D-C stationary contact 26. During this period of time the push rod 46 is in its lowest position and hence the bridging contact associated with the structure 16 is biased into contact engagement by the helical spring associated with the contact assembly 16.

On the next half cycle, the position of the push rods 46 and 47 will be reversed by the bell crank 44 so that the push rod 47 will be in its lowest position and the push rod 46 will be in its uppermost position. Hence, at this time the bridging contact 31 associated with the contact block assembly 15 will be in engagement with its associated stationary contacts 28 and 26 and the bridging contact associated with the contact block assembly 16 will be disengaged from its associated contacts 25 and 27.

Thus, throughout a complete cycle of operation the bridging contacts will also complete a mechanical cycle of operation.

The contact structures 15 and 16 of Figure 2 are then shown as being housed in a substantially air tight housing 50 in which a portion 51 has been cut away to allow visual access to the contact structures. The air tight housing 50 is shown as being attached to an air cooling system which includes the ducts 52 and 53, cooling coil 54 and a circulating means 55 which could be any desired type of blower or fan.

It is to be understood that if the other two phases were shown in the drawing, the air tight hood 50 could encompass all six contacts, or if desired each pair of contacts of the other two phases could have an individual air tight housing which would be supplied with an air flow between the ducts 52 and 53.

In accordance with the essence of the instant invention, a portion 56 of the duct 52 has been cut away and an indication has been made therein of a lining 57 which has been imparted to the duct 52. A similar lining is shown as being imparted to a broken section 58 of the duct 53. Similarly another lining could have been made in the ducts of the cooling coil 54 as shown within the cut-away portion 59 of the coil 54.

It is to be realized that the metallic linings 57, 58 and 59 could be of different materials, each one being chemically active with respect to a specific air impurity.

Similarly, it is to be understood that the complete duct need not be lined and that the complete cooling coil need not be lined. That is to say, it might be sufficient to merely line a portion of the duct or coil to thereby provide a chemically active surface which is large with respect to the active surface of the contact surfaces of contacts 15 and 16.

As a specific example, assume that the rectifier of Figure 2 operates in an industrial atmosphere having a high concentration of hydrogen sulphide. If the impurity of the air which is circulated through the contacts 15 and 16 is desired, then it will be apparent that this end can be achieved by lining either or all of ducts 52, 53 and cooling coil 54 with a copper internal surface.

In this case it is obvious that the copper lining, 57, 58 and 59, copper surface being much greater than the exposed silver surfaces of the contacts 15 and 16. Therefore very little reaction would be found between the hydrogen sulphide which is now at a greatly reduced level and the silver or silver alloy surface of the contacts 15 and 16.

Although I have shown a preferred embodiment of my invention, it will now be obvious that many variations and modifications will occur to those skilled in the art, and I prefer to be bound not by the specific disclosure herein but only by the appended claims.

1. A cooling system for mechanical rectifiers; said mechanical rectifier comprising a pair of cooperating contacts movable into and out of engagement with one another and means to synchronously move said cooperating contacts into and out of engagement with one another, an exposed contact surface of said cooperating contacts being at least partially constructed of silver, said cooling system being constructed to direct an air flow on said cooperating contacts for cooling thereof; said cooling system including a means for circulating air and air passages for conducting air from said circulating means to said cooperating contacts; at least a portion of the inner surface of said air passages being copper whereby substantially all impurities in said cooling air which are combinable with both copper and silver will combine with said copper surface, said silver surface of said cooperating contacts being substantially uncontaminated by said impurities.

2. A cooling system for mechanical rectifiers; said mechanical rectifier comprising a pair of cooperating contacts movable into and out of engagement with one another and means to synchronously move said cooperating contacts into and out of engagement with one another; said cooperating contacts having silver contact surfaces, said cooling system being constructed to direct an air flow on said cooperating contacts for cooling thereof; said cooling system including a means for circulating air and air passages for conducting air from said circulating means to said cooperating contacts; at least a portion of the inner surface of said air passages having a metallic lining whereby substantially all impurities in said cooling air which are combinable with both the metal of said lining and silver will combine with said lining,
said silver surface of said cooperative contacts being substantially uncontaminated by said impurities.

3. A cooling system for mechanical rectifiers; said mechanical rectifier comprising a pair of cooperative contacts movable into and out of engagement with one another and means to synchronously move said cooperative contacts into and out of engagement with one another, said cooperative contacts having silver contact surfaces; said contacts being housed in a substantially air tight housing, said cooling system being constructed to recirculate an air flow on said cooperative contacts for cooling thereof; said cooling system including a means for circulating air, air passages for conducting air from said circulating means to said cooperative contacts and a heat exchanging means; the inner surface of said heat exchanging means having a metallic lining whereby substantially all impurities in said cooling air which are combinable with both copper and silver will combine with said metallic lining, said silver surface of said cooperative contacts being substantially uncontaminated by said impurities.

4. A cooling system for mechanical rectifiers; said mechanical rectifier comprising a pair of cooperative contacts movable into and out of engagement with one another and means to synchronously move said cooperative contacts into and out of engagement with one another, said contacts being composed of a material including silver; said cooling system being constructed to direct an air flow on said cooperative contacts for cooling thereof; said cooling system including air passages for conducting air to said cooperative contacts; said air passages being lined with a first and second metal, the area of said first and second metal linings being large in comparison with the area of exposed contact surface of said cooperative contacts, said first metal being combinable with a first impurity in said cooling air, said second metal being combinable with a second impurity in said cooling air, said contact surfaces thereby being substantially unaffected by said first and second impurities.

5. In a rectifier for energizing a D.-C. load from an A.-C. source; said rectifier including a commutating reactor, a pair of cooperative contacts and means for synchronously operating said pair of cooperative contacts into and out of engagement; said A.-C. source, commutating reactor, pair of cooperative contacts and D.-C. load being connected in series, said commutating reactor providing low current steps during operation of said cooperative contacts into and out of engagement, said cooperative contacts being enclosed in a substantially air tight housing, a cooling system for said contacts, said cooling system including an air circulating means and passages for conducting air from said circulating means to the contacting surfaces of said contacts, said passages having a first and second portion coated with a first and second metal, said first metal reacting with a first substance which also reacts with the material of the cooperative contact surfaces, said second metal reacting with a second substance which reacts with the material of the cooperative contact surfaces, said cooperative contacts being constructed of a material including silver.

6. A cooling system for electrical contacts; said cooling system including an air circulating means and passages for conducting air from said circulating means to the contacting surfaces of said contacts; at least a portion of said passages being coated with a metallic substance; said metallic substance being combinable with impurities in the cooling air which are combinable with the material of said cooperative contact contacting surfaces.

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