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IMPROVED ELECTRIC GRID RESISTOR HAVING STAINLESS STEEL RESISTIVE ELEMENTS

1. Field of the Invention

The present invention relates to an improved electric grid resistor having stainless steel resistive elements for use in electrically driven mobile machines as a braking mechanism.

2. Background of the Invention

The technology relating to brakes dates back to the origin of mobile machines. A braking mechanism, in ordinary parlance, is a device for slowing or stopping a vehicle or other moving mechanism by the absorption or transfer of the energy of momentum, usually by means of friction.

Parallel to the advent of technology in the area of electric mobile machines, there has been a development of technology in the area of electric braking. The present invention is an improvement in the conventional art in this area. In the prior art, grid resistors are designed and manufactured for stationary applications, which are used in mobile machines. These grid resistors use conventional resistive alloys with high specific resistance, so as to obtain resistive elements, which have adequate thickness, so that the grid is mechanically strong to withstand dynamic forces. The conventional resistor unit also takes up a lot of space, as the heat produced has to be dissipated. To withstand the high temperature, grid resistors used in stationary applications use porcelain as an insulation element together with fireclay and fire cement. Since these materials are very brittle once they are set, special anti vibration mountings are required for these grid resistors to prevent vibration damage. As cast iron (a widely used resistive material) is brittle it is not suitable for such applications.

The present invention is a substantial improvement from the known and existing art as it involves various novel features including the composition of the resistive elements. These features provide the grid resistor herein described with various functional attributes enabling it to overcome various defects. The present invention is sufficiently distinctive over the art disclosed in various patent documents as well. The United States patent titled 'grid resistor' numbered 4, 100, 526 in the name of Kirriloff *et.al* dated July 11, 1978 relates to frame supported grid resistor having a plurality of resistors of the ribbon type located between adjacent ribbon resistors, strips of conductive material containing nonconductive bushings, which engage and separate the adjacent ribbon resistors. This patent has cross references to United States Patents numbered 2873510 in the name of Schoch dated February, 1959 and United States Patent numbered 4051252 in the name of Luv dated September 1977 and also to a German Application [printed] in the name of Tungs numbered 1465881 dated January 10, 1964.

The above inventions are addressed to grid resistors having the basic apparatus and methods for electric braking whereas the recent developments in this area relates to improvements in the functional attributes of grid resistors so as to bring in better efficiency in its working. The Japanese patent numbered JP6112005A2 titled "Grid Resistor" in the name of Toshiba Corporation dated April 22, 1994 addresses a specific deficiency of conventional grid resistors, ie., the excessive noise that it generates. The European patent application [published] titled "Dynamic Braking Grid Resistor Configuration for Reducing EMI in an Electric Vehicle" numbered 94307315.5 dated [date of publication] April 26, 1995 in the name of General Electric Company is also specifically aimed at reducing EMI generated by dynamic electrical braking.

The invention herein described is distinctive from the art disclosed in all the above referenced patents as it comprises of an electric grid resistor having stainless steel resistive elements made of austenitic stainless steel containing 16 to 20 per cent chromium and 6 to 22 per cent nickel and/or ferritic stainless steel containing 12 to 30 per

cent chromium and without any nickel. This novel feature distinguishes the invention herein described from all the aforementioned known arts in this field.

In the known art in the field, the method of manufacture of resistors, grids are built up by joining individual elements of strip/ribbon by bolting them together. Bolted joints become loose due to vibrations hence special precautions have to be taken when these grid resistors are used on mobile equipment where vibrations are present.

The existing method, as mentioned earlier, employs resistive alloys of high specific receptivity to ensure mechanical strength and rigidity to withstand vibration and mechanical stress. As these grid resistors have to be of low resistance value with high current ratings, hence they become very heavy. This is a great disadvantage since the apparatus is mounted on the machine and there is an increase in the machine dead weight. As the apparatus has to be handled manually on the machine, the weight of the resistors is a very important consideration. The resistive alloys are very expensive and as a large quantity of material is required, these conventional grid resistors are also very expensive.

These machines are used for construction & mining applications; hence they have to negotiate difficult terrain and steep gradients. When going down a gradient, the method of speed control of the electrically driven mobile machine would be by dynamic retardation, this would cause continuous heating of the grid resistors, as the energy of the downward motion will be continuously dissipated in the grid resistors as heat energy.

The grid resistors that are currently in use encounter with a number of technical problems. One such deficiency is the incapacity to withstand the vibration that the grid resistors encounter. The vibration encountered by the grid resistors would be very high, as they have to be located on the mobile machine itself.

Due to the sudden surges of high current in the resistors (when brakes are applied) high dynamic forces are also created in them, hence they have to be mechanically strong to withstand the dynamic forces without any damage.

There are various disadvantages of using conventional resistor grids for mobile applications. The conventional resistors use resistive alloys of high electrical specific resistance, hence units are heavy and expensive.

The conventional grid resistors are designed for stationary application. Hence the application of such resistors in mobile machines encounters with a major deficiency, mechanically in the body of the equipment. The grid resistors that are currently in use are known for its incapacity to check high vibrations especially encountered on application on mobile machines.

The object of this invention is to devise an electric braking system, which satisfies the special requirements of application on high vibration, mobile machines, thereby eliminating the drawbacks of using conventional resistor grids for mobile applications listed above.

It is also the object of this invention to have an apparatus that is easy to construct and to use readily available inexpensive material, so that the end product not only serves the specific application, but is also affordable in price.

All material selected for use in this apparatus is non-inflammable or flame retardant in nature, it ensures elimination of any fire hazard on the mobile machines due to these resistors. The raw material selection has been done keeping in mind the severe climatic conditions & the resistor units are highly corrosion resistant, hence suitable for mining/construction industry.

3. Summary of the Invention

Heavy mobile machines (e.g. dump truck loaded with iron ore) used in mining applications, have large diesel engines as prime mover. These machines are driven by coupling the wheels to the output shaft of the prime mover through gearing arrangements

& other mechanical devices. The large modern machines being used in the present day mining industry are electrically driven. The diesel engine is used to run electric traction motors, which in turn, drive the wheels of the machine. Since electric motors are used for the wheel drives, dynamic retardation of the motors (electric braking) can be applied. This is achieved by turning the wheel motors into generators and dissipating the current produced through low resistance grids. The passage of current through the grids produces a counter torque, which slows the motor down. The energy of motion is dissipated in the resistance grids and it re-appears as heat energy in the grid resistors. Since electric wheel drives are used only in very large machines hence the energy to be dissipated is also very large (to the extent of 1000 KW or higher)

4. Brief Description of the Drawings

This invention is explained with reference to the accompanying drawings. Fig.1 is a diagram of the lay out of the resistor unit in whole and Fig.2 is a diagram of the layout of the resistor in part.

5. Detailed Description of the Invention

The resistive elements of the grid resistor (A) are supported between two flame retardant F.R.P supports at top (C) & bottom (C1). The resistive elements are separated from one another with the help of ring supports (B) and thin mica washers. An M.S. rod (D) with threading at each end is run through a porcelain pipe (E), which passes through the punched holes in the resistive elements (A). The porcelain pipe also runs through the ring type spacers (B) holding them in position. The pipe (E) also electrically insulates the bracing rod (D) from the resistive elements. The bracing rod (D) has tightening nuts at both ends. The nuts are tightened to ensure a rigid assembly & then lock pins (split pins) are placed on the rod, so that the nuts are locked in position and are unable to loose in case of vibrations. Stainless steel locking pins (H) are welded 2 Nos. at each joint end of the resistive elements. (A) These pins enter into holes located at the bottom side of top support (C) and upper side of bottom support (C1). So once the bracing rods (D) are

placed in position & tightened and the top(C) & bottom (C1) supports are fitted to the resistive elements assembly, the individual resistive elements are locked in a place. The holes in the top (C) & bottom (C1) supports have adequate depth to accommodate the thermal expansion of the strips when heated.

The stainless steel connectors (G) welded to the starting end of the resistive element strip & the finishing end of the last resistive element strip are brought out through flame retardant F.R.P supports (K) one at each side. These can be used as mounting brackets cum electrical connection point.

The resistive element is built up by welding together strips of resistive material previously cut to size, punched and formed. The strips are welded together in such a way that a long continuous resistive element is formed in the formation as shown in Fig.1.

The overall dimensions of the resistor unit as well as the type, thickness and dimensions can be varied as per the requirement of current rating & resistance value of the resistor unit. Two heavy gauge M.S. end covers (L) are bolted on to the top (C) & bottom (C1) supports at each end, so that there is no approach to the resistive elements (A) from the two sides.

When more than one resistor is used in a machine, the resistors can be mounted in a bank adjacent to one another (Ref. (C & C1) Fig.2). The top & bottom supports & end covers (L) of the adjacent units touch each other, so that a box like arrangement with two open ends is achieved. By blowing in air from one end the stream of air passes over all the elements in the bank, as the top & sides are closed, the air can only flow from one end to other end of the bank. This arrangement makes forced air-cooling very efficient for this apparatus.

Two stainless steel strips are also fixed to the top F.R.P. support (C1). As these steel strips are good conductors of heat, heat dissipation is improved. Steel angles of adjacent

units touch each other, thereby preventing any leakage of air under forced cooling conditions.

The resistor units comprise of the following parts (Ref Fig.1)

A) Resistive element for resistance grids comprising of elements of.

1. Austenitic Stainless Steel containing 16% -22% Chromium and 6-22% Nickel.
2. Ferritic Stainless Steel containing 12-30% Chromium and without any Nickel.

In the correct proportion required for achieving desired resistance value and mechanical strength.

B) Ring Supports of steatite /porcelain of high compressive strength with mica spacers

C) Non -flammable F.R.P supports. (Top)

C1) Non- inflammable F.R.P supports. (Bottom)

D Bracing (supports for mechanical strength & rigidity) of 8-10 mm mild steel threaded & pinned at ends with tightening nuts.

E) Heat resistant, insulating tube for insulation of bracing rod.

F) Flame proof insulation.

G) Stainless steel connection cum. mounting brackets

H) Stainless steel locking pin.

K) Flame retardant F.R.P end terminal support.

L) Heavy gauge M.S end covers.

The invention herein described exhibits the best mode for working the technology contained therein. It is specially designed to withstand high vibrations levels encountered in large mobile machines, eliminating the drawbacks of using conventional resistor grids designed for stationary application on mobile machines.

The invention herein described uses very thin cross section strips for making grid elements hence light in weight. As electric braking systems are mounted on mobile machines, the lighter weight reduces machine dead weight. The system uses non-inflammable or flame retardant material hence is the best mode of eliminating the fire hazard due to overheating of grids. It is used in this invention easily available resistive material hence cheaper than conventional grid resistor units. Further the electric braking system as described herein is easy to construct and manufacture. Also the system is light and easy to handle with simple means of mounting on machine, which reduces installation and removal time.



What is claimed is:

1. An improved electric grid resistor having resistive elements (A) supported between two flame retardant supports (C and C1) comprising:
 - an MS rod (D) that passes through the punched holes in the said resistive elements;
 - a porcelain pipe (E) that runs through ring supports (B) holding them in position;
 - two stainless steel connectors (G) welded to the starting end of the first resistive element strip and the finishing end of the last resistive element strip;
 - two flame retardant supports (K) through which the said resistive elements are brought through on either sides; and
 - two heavy gauge end covers (L) bolted or welded to the said resistant porcelain supports.
2. The improved electric grid resistor according to claim 1, wherein the said resistive elements are separated from one another with the help of the said ring supports and thin mica washers.
3. The improved electric grid resistor according to claim 1, wherein the said porcelain pipe is employed to electrically insulate the bracing rod from the resistive elements.
4. The improved electric grid resistor according to claim 1, wherein the said MS rod further comprises tightening nuts at both ends;
5. The improved electric grid resistor according to claim 4, wherein the said tightening nuts are employed for ensuring a rigid assembly with the help of the lock in pins (H) connected therein so that the said system is not loosened in vibrations.



6. The improved electric grid resistor according to claim 5, wherein the said lock in pins are welded to and joined at either ends of the said resistive elements;
7. The improved electric grid resistor according to claim 6, wherein the said lock in pins are placed in a manner so that the said pins enter into respective holes located at the bottom side of the top support and upper side of the bottom support;
8. The improved electric grid resistor according to claim 1 further comprising two stainless steel strips connected to the top flame retardant support.
9. The improved electric grid resistor according to claim 1, wherein the said resistive elements further comprising of elements made of austenitic stainless steel containing 16 to 20 per cent chromium and 6 to 22 per cent nickel and/or ferritic stainless steel containing 12 to 30 per cent chromium and without any nickel.
10. The improved electric grid resistor according to claim 9, wherein the said resistive elements are made of the said chemical substances in such proportion so as to achieve desired resistance value and mechanical strength.
11. A method of braking using an improved electric grid resistor according any of the preceding claims.
12. The invention as substantially described herein and claimed in any of the preceding claims and supported with the figures.