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SYSTEM FOR PREVENTING ARC RE-IGNITION
IN ELECTROSTATIC DUST SEPARATORS
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Fig. 1

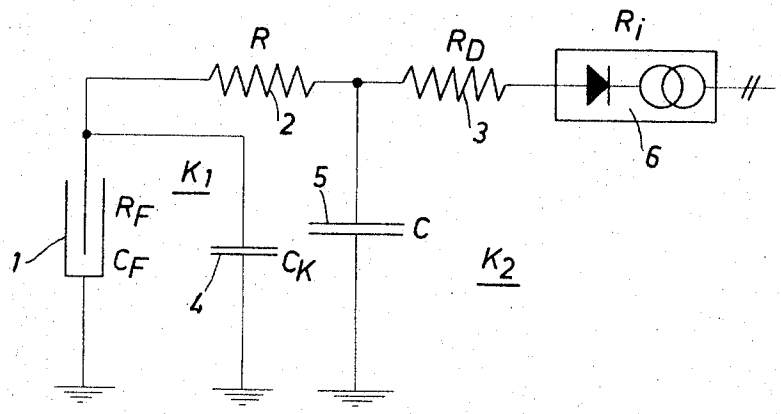
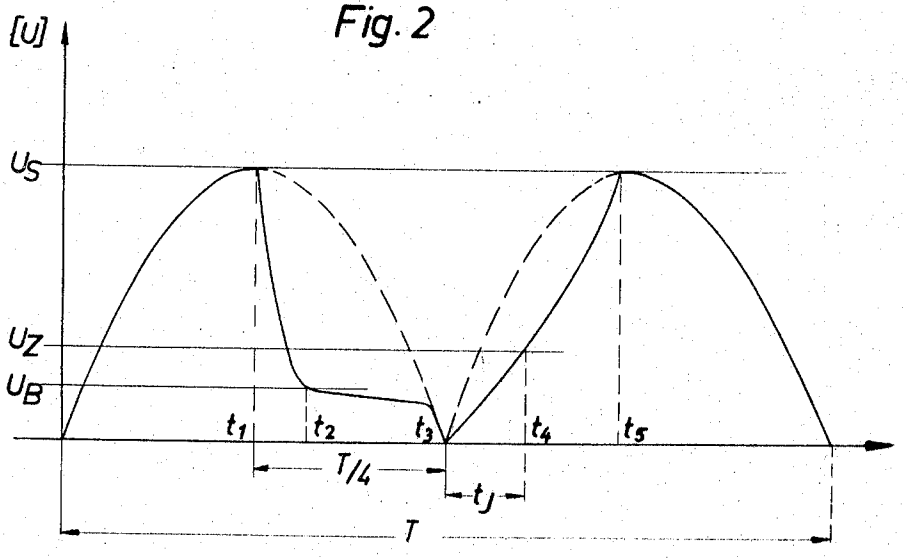


Fig. 2



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SYSTEM FOR PREVENTING ARC RE-IGNITION IN ELECTROSTATIC DUST SEPARATORS

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1 Claim. (Cl. 55—105)

ABSTRACT OF THE DISCLOSURE

A time delay condenser is added to the voltage control circuit in an electrostatic dust separator so that after an arc has been extinguished the voltage is not brought back to normal until after the gas in the separator is de-ionized.

In practice, it has been found that the emitting electrodes in electrostatic dust separators characteristically vibrate toward the precipitating electrodes when the voltage between the emitting and precipitating electrodes changes or breaks down. This increases the danger that voltage changes or short circuits occur and also increases the danger of continuous arcing. The high voltage control apparatus is therefore adjusted so that, when such electrical disturbances occur, the entire electrical system is reduced to lower voltages or completely shut off.

It is clear that this technique considerably reduces the medium value of the electric current which reduces the amount of dust precipitation in the precipitator. It has been suggested that the effective amount of dust precipitation can be increased by connecting condensers in parallel with the precipitator, such as disclosed in German Patent No. 478,386. However, this disclosure notes that, because of condenser peculiarities, surges are produced in the circuit and the condensers have not proved satisfactory. It has been further disclosed that these surges in the condenser circuits can be suppressed by eliminating the ohm resistors. Half lines inserted into the condenser branch line have been proposed as the ohm resistors.

Tests of the above suggestions have shown that the operation of the dust precipitator becomes very unsteady. Contrary to all expectations, continuous or prolonged arcing occurs immediately because of the added resistance even as a so-called half line or the lost resistance. This result is explainable because the time constant for discharging the parallel coupled condensers has risen considerably by reason of the lost resistance at all times coupled in series with one condenser. This means that the parallel operating condensers are discharged at a considerably slower rate and under certain circumstances only partially discharged so that, before the electric current is again increased, the arcing current has not been reduced and therefore the arcs are reignited and heavy arcing occurs. It was thought that these things might be avoided if the resistance and capacity values were changed. However, these efforts did not give the anticipated results.

Among the many prior art patent disclosures, attention is directed to German Patents Nos. 426,149 and 448,034. These disclose proposals for the sizes of parallel operating condensers, but do not produce satisfactory operating results.

In this invention, it has been surprisingly found that the aforementioned disadvantages are immediately eliminated when the lost resistance or resistances are coupled in front of the discharge condenser and dust precipitator and/or immediately behind the current supply. The size

of the discharge condenser is dependent upon the time required for the gas in the precipitator to become de-ionized and sets the time for the reduction of the current in the precipitator. The re-ignition of the arcs which have been extinguished is completely eliminated and the precipitator operates quietly.

This invention therefore is for a system to avoid the re-ignition of arcs due to the increasing of the current between the precipitator electrodes after the arcs have been extinguished by lowering the current coupling the lost resistance in front of the discharge condenser and the dust precipitator and/or behind the current source with the discharge condenser having a capacity which is equal to or less than the quotient of the time required for the de-ionizing of the gas in the precipitator after an arc has been extinguished, divided by five times the sum of the interior resistance and the ohmic resistance, further the capacity is equal to or smaller than the quotient of the current ratio divided by twenty times the sum of the interior resistance of the precipitator, plus the combined resistances in the dust precipitator electrode circuit, and minus the sum of the dust removal capacity of the precipitator plus the cable capacity.

This invention achieves, because of the elimination of the prolonged or continuous arcing or voltage breaks or high intensity short circuits, the vibration of the emitting electrodes. The borderline or arc-over has been shifted to higher values which considerably increases the dust precipitating efficiency of the precipitator.

The means by which the objects of the invention are obtained are described more fully with reference to the accompanying drawings in which:

FIGURE 1 is a circuit diagram of the electrical system; and

FIGURE 2 is a curve showing the current timing in the precipitator.

The electrostatic precipitator **1** has a current source **6**. The relatively small line resistances R are combined in resistance **2**. The ohmic resistance R_D is the resistance **3**. Condenser **4** is a replacement coupling for the cable capacities C_K. The condenser **5** is coupled in parallel with the precipitator **1**. The partial circuit K_1 is that composed of elements **1**, **2** and **5** and, in a transferred meaning, also **4**. The partial circuit K_2 is composed of the elements **5**, **3** and **6**. When a short circuit occurs in precipitator **1**, especially due to arcing, the condenser **5** is discharged in a very short time, as, for example, a fraction of a millisecond. Since, as long as arcing continues, the entire resistance in circuit K_1 as opposed to the resistance **3** in circuit K_2 can be ignored. Almost all of the current produced by the source **6** falls off at resistance **3**. The source **6** in practice, however, is usually in a position to support arcing as far as the current is concerned until, because of the current curve produced by source **6**, the burning current U_B of the arc is reduced and the arc extinguished. As shown in FIGURE 2, assuming that the short circuit in the precipitator **1** occurs just at that point when the first half wave of current has reached its highest value, the current curve runs purely schematically according to the drawn curve within the second quarter period of the identically directed alternating current. Assuming that the short circuit occurs at time t_1, the current curve follows the *e*-function, and at time t_2 reaches the burning current U_B of the arc. At time t_3 it reaches the zero line. Without the presence of the parallel operating condenser, the current would rise again as shown by the dashed line. The parallel operating condenser retards the rise in current because of its loading which is by reason of the resistance **3** and the source **6**. The current curve thus moves along the unbroken line again up to its highest point and according to the *e*-function. At time t_4 it exceeds the ignition cur-

rent U_Z of the gas passageway in precipitator **1** which has been previously ionized by the arc. When the time between t_3 and t_4 is equal to or larger than the time which the gas in precipitator **1** requires for its ionization, then at time t_4, despite the fact that this ignition limit is exceeded, the arc is not re-ignited. At time t_5 the current then again reaches its normal value. It is clear that the arc ignites always at those times when the time difference of the succeeding time periods t_3 and t_4 is smaller than the time t_j which represents the time that it is necessary to de-ionize the gas in precipitator **1**. Without the presence of the discharge condenser, therefore, the current would follow the dashed line at the intersection of this curve with the ignition current U_Z and the arc would re-ignite. Because the discharge condenser in circuit K_2 is charged, the displacement of the current curve towards the larger time is caused and makes impossible the re-ignition of the arc.

Assuming a normal dust precipitation operation, then the inner resistance R_I of the current source **6** is about 75 kilohms. The source **6** has a rating of about 20 kva. at a current flow of approximately 280 milliamperes. The ohmic resistances R_D are usually resistances in a range of values from about 5 to 6 kilohms. The cable capacity C_K is about 30 nf. while the precipitation field capacity is approximately 12 nf., and thus the approximate total capacity of the precipitator with two field C_F is about 25 nf. The sum of the two resistances R_F and R is up to about one-half kilohm. From these values, it is clear that, when the ohmic resistance **3** is introduced into the circuit K_1, the time of discharge of the condenser **5** is very large, which means the condenser **5** has no possibility of discharging quickly across the precipitator. On the other hand, it is clear that when studying circuit K_2 that the charging of condenser **5** is very quickly accomplished when resistance **3** is not coupled in this circuit. This means, however, that the current substantially earlier reaches the value of ignition U_Z.

The capacity of condenser **5** according to this invention is subject to the two mentioned conditions. The charging time t_L of the condenser must be at least equal to or greater than the time t_j which is required for the ionization of the gas; t_L is calculated from the equation $t_L=5(R_I+R_D)\times C$. If then t_j is substituted for t_L and the sign $\geq$ replaces the equal (=) sign, the result is the first condition for C: therefore C is

$$C\leq\frac{t_j}{5(R_i+R_D)}$$

This is derived from the circuit K_2. A further equation results as follows: the constant τ for the circuit K_1 is found as follows:

$$\tau=(R+R_F)(C+C_K+C_F)$$

Since a discharge after 5 time constants is practically finished, the result for the discharge time is:

$$t_\tau=5\cdot\tau=5\cdot(R+R_F)\cdot(C+C_K+C_F)$$

Since the discharge time t_τ, however, is not supposed to exceed a fraction of the duration period and, if possible, not to exceed one-fourth of this time, we find

$$t_\tau\leq\frac{T}{4}$$

$$5(R+R_F)(C+C_K+C_F)\leq\frac{T}{4}$$

and thus for C the equation

$$C\leq\frac{T}{20(R_F+R)}-(C_F+C_K)$$

Tests made with the prior art circuits show that, when the ohmic resistance **3** was not coupled into the circuit K_2 but into the circuit K_1, the following results:

Time constant $\tau=0.743$ millisecond;
Discharge time $t=3.72$ milliseconds;
Total loading time constant $t_L=4.13$ milliseconds.

In comparison, tests of the system of this invention give the following results:

Time constant $\tau=0.083$ millisecond;
Discharge time $t=0.415$ millisecond;
Total loading time constant $t_L=12.3$ milliseconds.

The surprising technical advance of this invention is clear from a comparison of the above values. According to the prior art, the discharge in circuit K_1 is too slow and in circuit K_2 it is too fast. Transferred to FIGURE 2, this means that in circuit K_1 the unbroken current curve between points t_1 and t_3 would again reach the dashed curve above the arcing current value. On the other hand, while looking at circuit K_2, the unbroken curve of the current would achieve in the second half wave of identically directed alternating current the ignition current U_Z at the time point t_4 which is less than the de-ionizing time t_j.

Having now described the means by which the objects of the invention are obtained, I claim:

A system for preventing the re-ignition of electric arcs in an electrostatic dust precipitator in which a condenser is coupled parallel the emitting electrode in the precipitator so that when the current to the electrode is decreased to extinguish an arc it is then increased to again energize the electrode, further comprising a discharge condenser (**5**) coupled in parallel with said electrode, a source of electricity (**6**) for said electrode, an ohmic resistance (**3**) connected between said discharge condenser and source of electricity, said discharge condenser having a capacity C which is equal to or less than the quotient of the time t_j required for the de-ionizing of the gas in the precipitator after an arc has been extinguished divided by five times the sum of the interior resistance R_I and the ohmic resistance R_D as stated in the formula

$$C\leq\frac{t_j}{5(R_I+R_D)}$$

and that the capacity C is equal to or smaller than the quotient of the current duration time T divided by twenty times the sum of the precipitator interior resistance R_F plus the combined smaller resistances R in the dust precipitator partial circuit K_1, and minus the sum of the dust removal capacity C plus the cable capacity C_K as stated in the formula

$$C\leq\frac{T}{20(R_F+R)}-(C_F+C_K)$$

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