No. 897,212. PATENTED AUG. 25, 1908.

K. KUHLMANN.

LIGHTNING ARRESTER.

APPLICATION FILED MAR. 15, 1907.

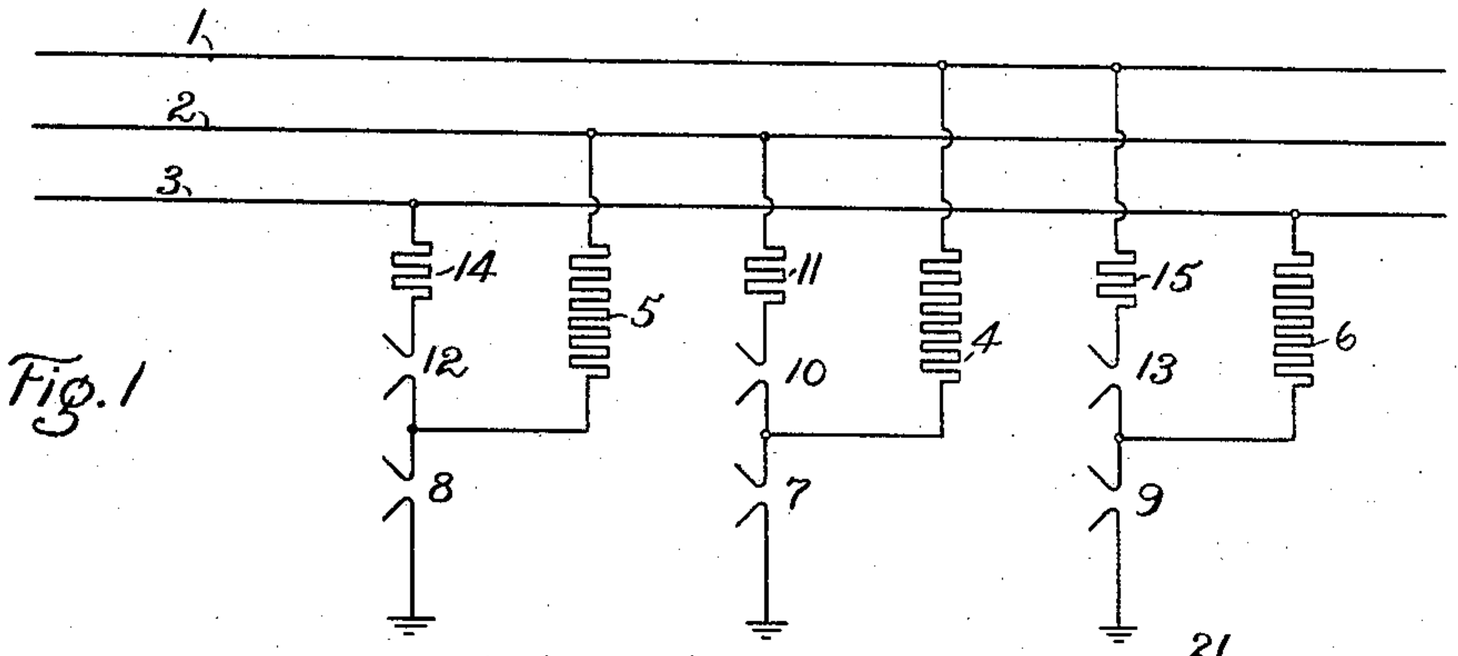

Fig. 1

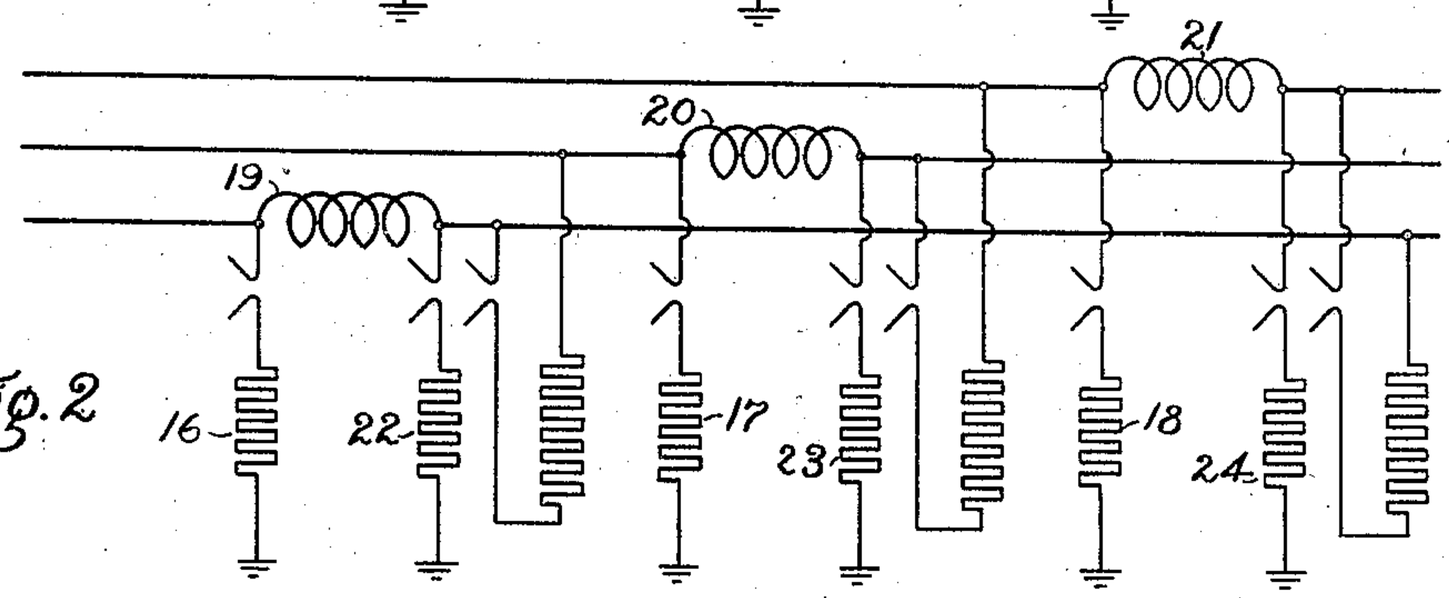

Fig. 2

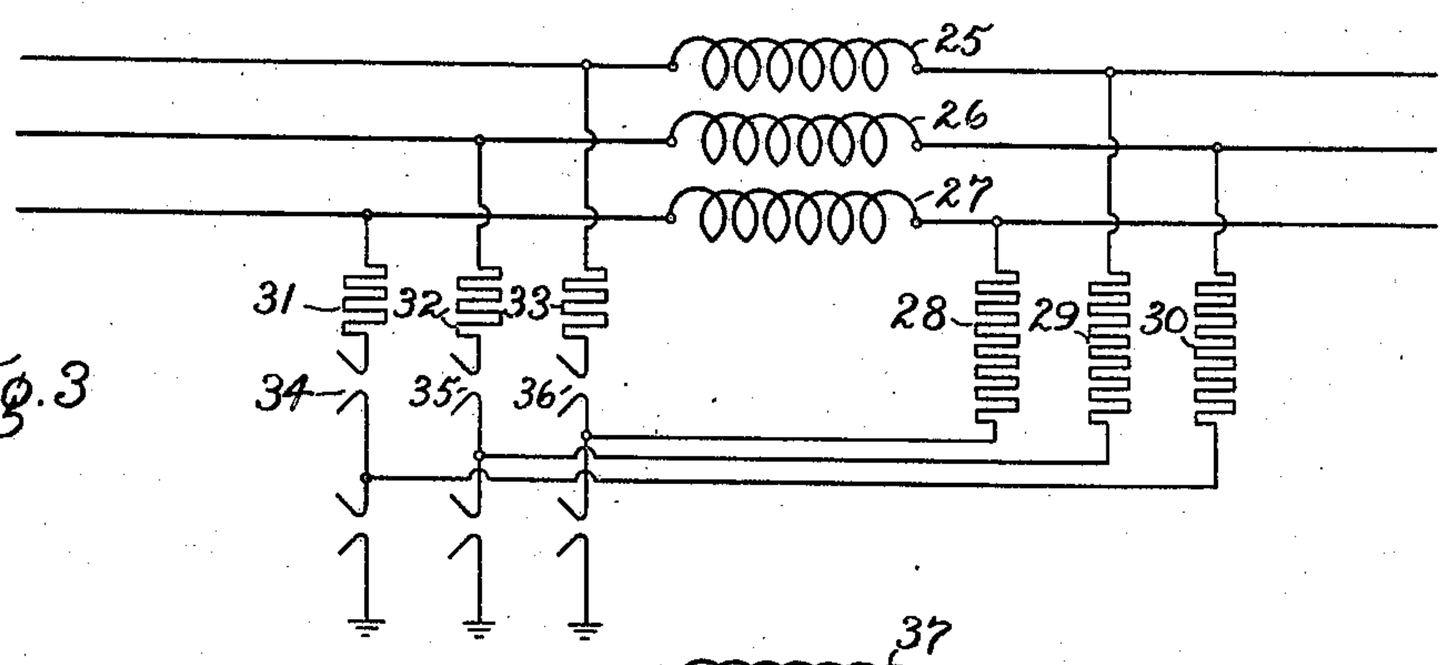

Fig. 3

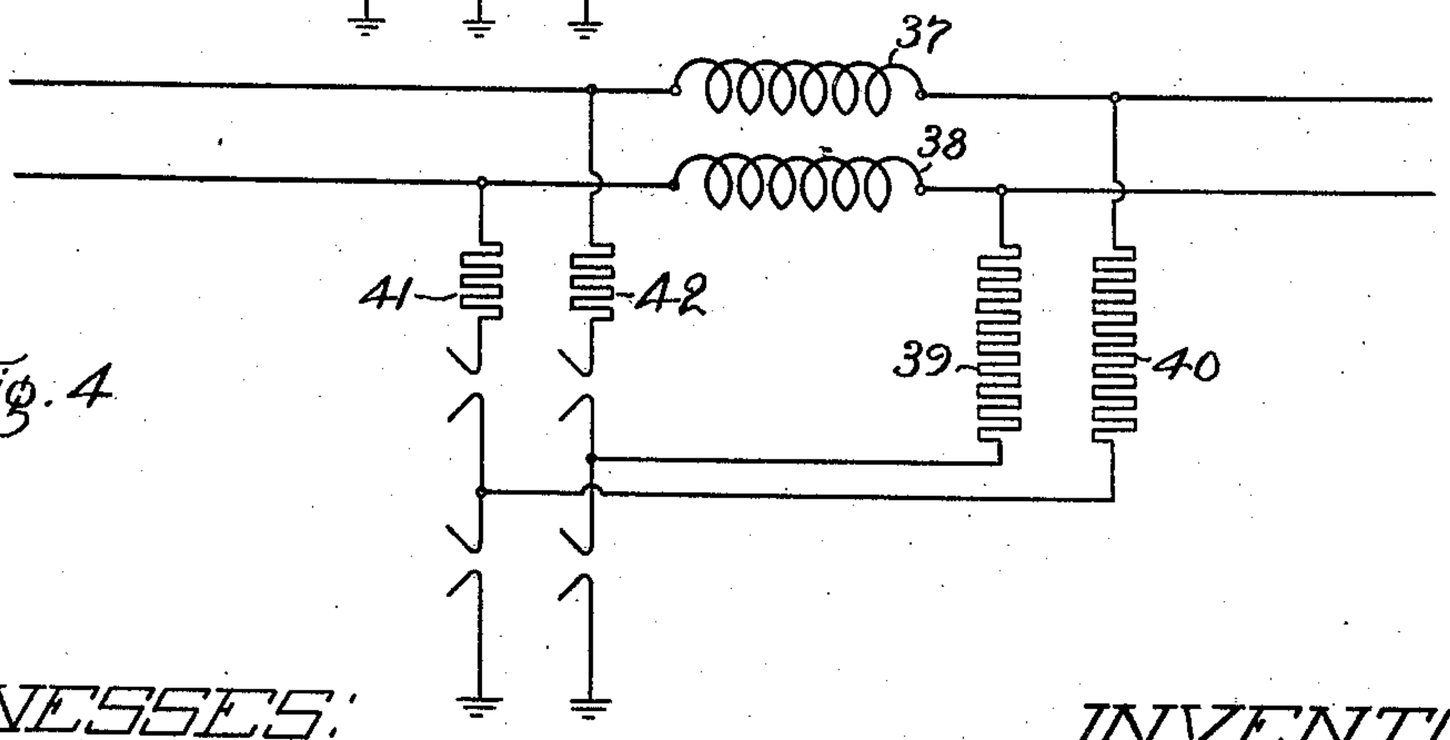

Fig. 4

WITNESSES:
Lester H. Fulmer.
J. Ulrich Ellen.

INVENTOR
KARL KUHLMANN.
BY Albert G. Davis
ATT'Y.

UNITED STATES PATENT OFFICE.

KARL KUHLMANN, OF BERLIN, PANKOW, GERMANY, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

LIGHTNING-ARRESTER.

No. 897,212. Specification of Letters Patent. Patented Aug. 25, 1908.

Application filed March 15, 1907. Serial No. 362,480.

To all whom it may concern:

Be it known that I, KARL KUHLMANN, a subject of the Emperor of Germany, residing at Berlin, Pankow, Germany, have invented certain new and useful Improvements in Lightning-Arresters, of which the following is a specification.

The use of spark gaps for protecting electrical systems against excessive potentials is now common. They are usually connected in series with resistances and are arranged to form discharge paths between the line conductors and between conductors and ground. Various groupings of the resistances and spark gaps have been proposed to decrease the total number of resistance units, but too little attention has heretofore been paid to the point of creating excess potential paths according to the frequency of the excess potentials. The number of oscillations of an electrical discharge is of essential influence on the path selected for its passage. Thus, for example, a high frequency discharge will choose a path through spark gaps or condensers in preference to that through ohmic resistance, since the latter cannot be so formed as to offer an entirely inductionless path to very rapidly alternating current.

The arrangement described below embodies the principles above set forth.

One novelty of the new arrangement consists in the special provision of paths for the rapidly oscillating pulsations.

In the accompanying drawing, Figure 1 is a diagrammatic representation of an electrical system protected according to my invention; Fig. 2 shows a system with reactance devices in series with the line conductors; Fig. 3 shows how the system of Fig. 2 can be simplified and improved; and Fig. 4 illustrates my invention as applied to a single phase circuit.

The protective means illustrated in Fig. 1 consists of a plurality of resistances and a plurality of safety devices, so grouped that a plurality of paths for current discharge are formed, the paths being radically different in reactive effect and therefore having a selective action on discharges of different frequencies. The safety devices above mentioned may be either spark gap or condensers. The line conductors 1, 2 and 3 of the three-phase system are connected respectively with the resistances 4, 5 and 6, and these are connected to ground through safety devices 7, 8 and 9. Each of these resistances is also connected in to another line conductor through safety devices and small resistances. Thus, resistance 4 is connected in to line conductor 2 through spark gap 10 and small resistance 11, and resistances 5 and 6 are similarly connected in through spark gaps 12 and 13, and resistances 14 and 15. The exact arrangement will be clearly understood by reference to Fig. 1 of the accompanying drawing. In this case, the discharge passing from a line conductor to earth, passes through only a single resistance, such as 4, 5, or 6, but a discharge passed between two line conductors passes successively through a large resistance, as 4, and a small resistance, as 11; there lies therefore, in the path of the greater potential, also the greater resistance.

The path above outlined is that for a discharge of relatively low frequency, and in case the charge on conductor 1 is of high frequency it passes to ground through small resistance 15 and safety devices 13 and 9. It will be understood that each line conductor is provided with two discharge paths to ground, one having a large resistance and a single safety device, and the other having a small resistance and a plurality of safety devices. It will be also understood that each conductor has two paths to any other conductor, one of relatively high resistance and suitable for low frequency currents, and the other containing less resistance and better adapted for very high frequency currents.

It is advantageous to employ the above described arrangement in conjunction with the choking coils which are often used as lightning protectors. If, for example, machines which are connected to an open-lead system are to be protected against excess potentials by using choking coils between conductor and earth, or between the individual conductors, three spark sections for each individual lead may be employed in series with three separate resistances. According to this scheme, a three-phase circuit requires nine sparking sections in all and nine resistances, as illustrated diagrammatically in Fig. 2. According to this arrangement, the grounded sparking sections 16, 17 and 18 are branched off before their respective choking coils 19, 20 and 21, and similar grounded sections 22 23 and 24 are branched off behind these choking coils.

In the arrangement shown in Fig. 3 the

choke coil for any conductor is connected between the two discharge paths leading from that conductor to the other. It is therefore no longer necessary to include excess potential safety devices in these connected paths. The choke coils 25, 26 and 27 serve to prevent an excessive flow of line current in case of a high potential discharge through any of the large resistances 28, 29 and 30, or through the low impedance paths including resistances 31, 32 and 33 and spark gaps 34, 35 and 36.

Fig. 4 shows the same general idea applied to a single phase system. Reactances 37 and 38 are included in the line conductors, the high resistances 39 and 40 are connected to the line conductors on one side of the reactance coils, and resistances 41 and 42 of lower magnitude are connected on the opposite sides of the reactance coils. The reactances may be considered as connected in series with the discharge paths and serve to choke down any abnormal flow of line current.

What I claim as new and desire to secure by Letters Patent of the United States, is,

1. The combination with a plurality of line conductors of an electrical system, of a high resistance and also a safety device and a low resistance forming a discharge path from one line conductor to another, and a safety device of low reactance connected between ground and the junction point of said high resistance with its safety device.

2. The combination with line conductors of an electrical system, of a reactance in series with each line conductor, a discharge path for abnormal charges, said path including a resistance and a safety device, said path connecting opposite ends of two of said line reactances to render the reactances effective for cutting down the flow of line current through said discharge path.

3. The combination with a plurality of conductors of an electrical system, of a reactance in series with each of said conductors, a discharge path connecting opposite sides of the reactances in two of said conductors, said path including a high resistance and also a safety device and a low resistance, and a safety device between ground and the junction point of said resistance with its safety device.

4. The combination with line conductors of a three-phase electrical system, of a discharge path between each conductor and every other conductor, each of said paths including a large resistance and also a safety device and a small resistance, and a ground connection for the junction point of each high resistance with its corresponding safety device, said ground connections being of low reactance and including a safety device.

5. The combination with line conductors, of an electrical system, of reactance coils in said line conductors, a discharge path from one line conductor to another for transmitting charges of relatively low frequency, said path including a large resistance and connecting opposite ends of two of said line reactances, and a path to ground for one of said line conductors, said path including a portion of the path between two conductors and having much less reactance than that of said large resistance.

In witness whereof I have hereunto set my hand this 23rd day of February, 1907.

KARL KUHLMANN.

Witnesses:
JULIUS RUMLAND,
KARL MICKEBEN.