(No Model.) 3 Sheets—Sheet 1.

T. GUILLEAUME.

ELECTRIC CABLE.

No. 554,263. Patented Feb. 11, 1896.

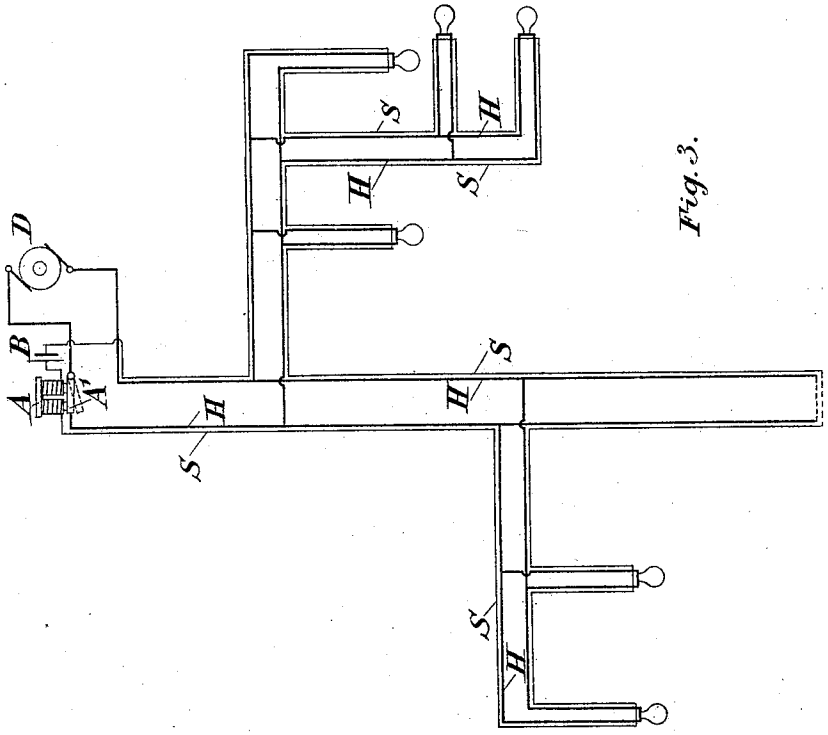

Fig. 3.

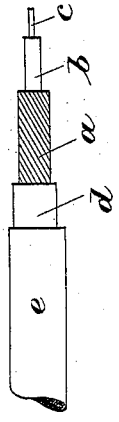

Fig. 1.

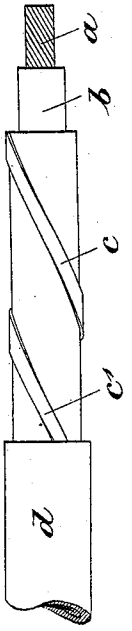

Fig. 2.

Witnesses.
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Fig. 5

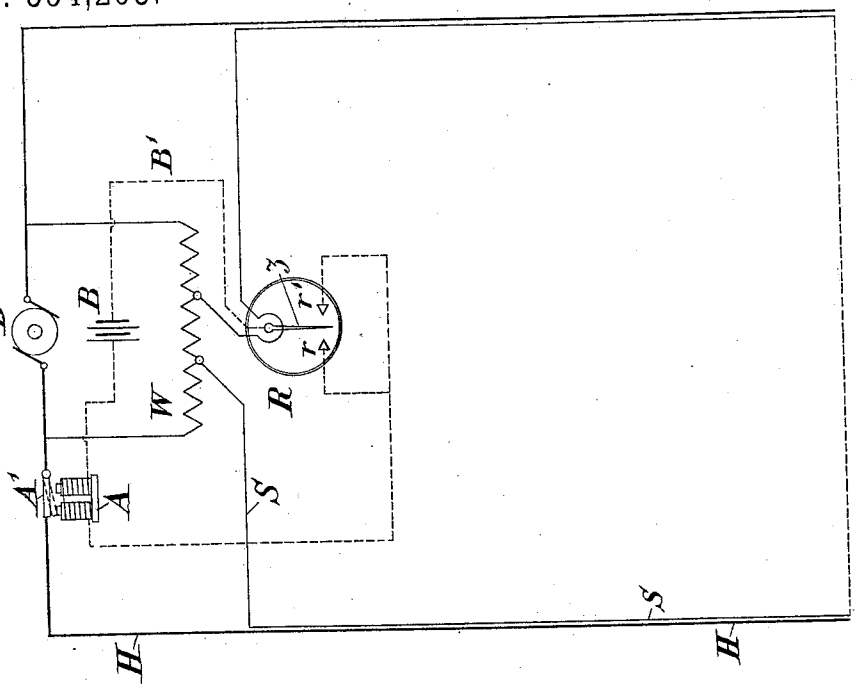
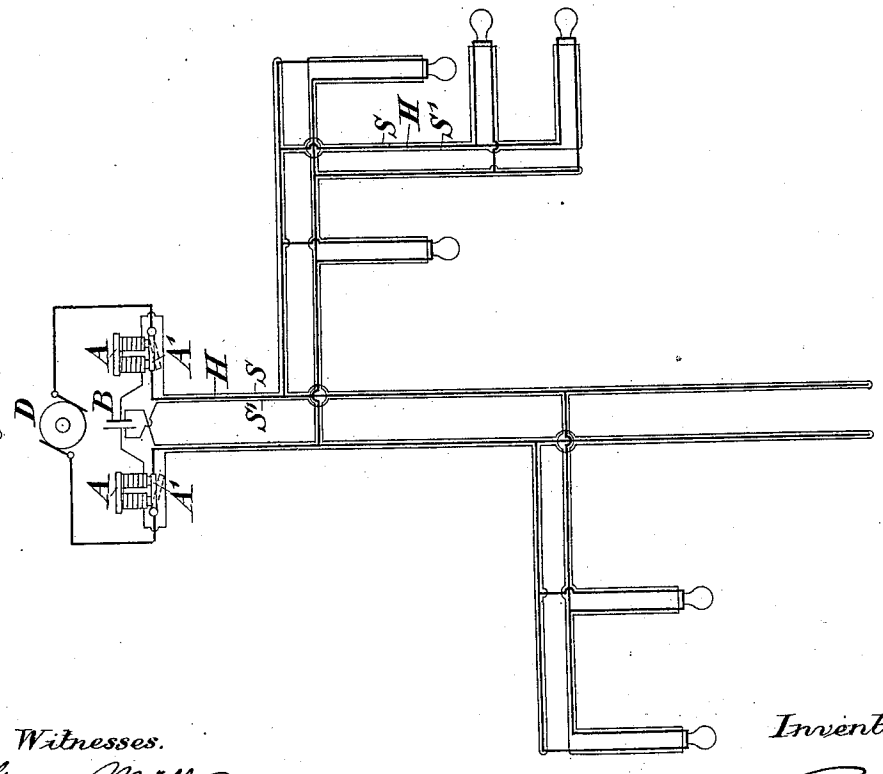


Fig. 4.



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ELECTRIC CABLE.

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Fig. 6.

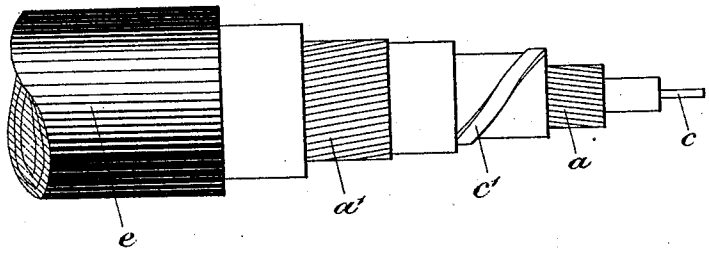
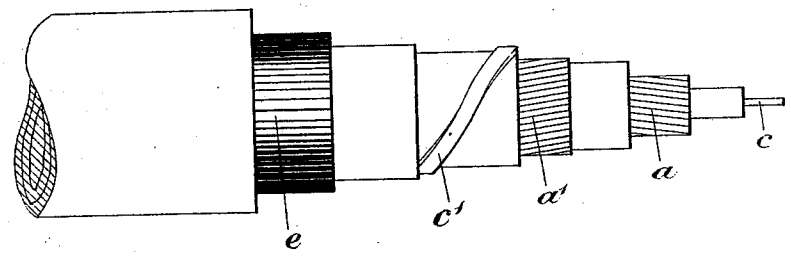


Fig. 7.



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UNITED STATES PATENT OFFICE.

THEODORE GUILLEAUME, OF MÜLHEIM-ON-RHINE, GERMANY.

ELECTRIC CABLE.

SPECIFICATION forming part of Letters Patent No. 554,263, dated February 11, 1896.

Application filed March 19, 1895. Serial No. 542,375. (No model.) Patented in England November 1, 1893, No. 20,698; in Belgium November 10, 1893, No. 107,113; in France November 11, 1893, No. 233,988; in Austria March 26, 1894, No. 2,313, and in Hungary March 26, 1894, No. 1,112.

To all whom it may concern:

Be it known that I, THEODORE GUILLEAUME, a subject of the German Emperor, residing at Mülheim-on-Rhine, in the German Empire, have invented new and useful Improvements in and in Connection with Electric Cables, (in respect whereof I have obtained or caused to be obtained Letters Patent in the following countries: Great Britain, dated November 1, 1893, No. 20,698; Belgium, dated November 10, 1893, No. 107,113; France, dated November 11, 1893, No. 233,988; Austria, dated March 26, 1894, No. 2,313, and Hungary, dated March 26, 1894, No. 1,112, and in respect whereof I have applied for but have not yet obtained Letters Patent in Germany to bear date September 19, 1893,) of which the following is a specification.

This invention relates to electric cables designed to obviate certain difficulties attending the employment of electrical currents in places where combustible substances or inflammable gases are present, one of such difficulties being that in the event of the conductor breaking the sparks emitted may cause ignition of the said substances or gases, and thus under certain circumstances—as, for example, in coal-mines—involve serious danger to life.

In a cable constructed according to this invention there is combined with the main conductor an additional or "safety" conductor made of less ductile metal than the main conductor. This safety-conductor serves, in conjunction with a switch device, to close the circuit whereby the main conductor is connected with the source of electrical energy. Should the main conductor be strained to a point rendering fracture imminent, the safety-conductor, owing to its inferior ductility, breaks, whereupon the current passing through the same is interrupted, and the switch in the main circuit is opened. The current passing along that conductor is thus intercepted or diverted before fracture of the main conductor can take place.

The invention is also adapted to guard against danger from sparking should the cable suffer injury by crushing.

In the accompanying drawings, Figure 1 represents in elevation a cable embodying a safety-conductor in accordance with this invention. Fig. 2 is a similar view of a cable provided with a safety-conductor and adapted to withstand external pressure or crushing. Fig. 3 illustrates the method of connecting a cable such as represented in Fig. 1, Fig. 4 illustrating the method of connecting the cable shown in Fig. 2. Fig. 5 illustrates the mode of combining a cable, such as Fig. 1, with a safety-switch, in order to provide against accidents which may arise either from excessive tension or from crushing. Fig. 6 is a side elevation of a cable illustrating the mode of construction when two or more safety-conductors in accordance with this invention are assembled together, Fig. 7 being a similar view showing a modification.

According to one mode of construction (illustrated in Fig. 1) the cable comprises a main conductor *a* surrounding a safety-conductor *c*, but separated therefrom by insulating material *b*. *d* is another insulating-covering and *e* an outer protective covering. The main conductor *a* is made of copper or other ductile metal and the safety-conductor of steel, bronze or other metal which, unlike the soft and ductile copper, will bear comparatively little elongation without breaking. In the event of the cable being subjected to excessive tensile strain the independent current traversing the safety-conductor *c* is first interrupted in consequence of that conductor breaking, the effect being that the main current is diverted from the principal conductor *a* before the latter breaks.

Where there is reason to apprehend crushing, the cable may be constructed as illustrated in Fig. 2. In this instance the safety-conductor *c c'*, in the form of a bipart steel tape, is wound round the insulated copper conductor *a* in a coarse pitch double spiral. Where such a cable is liable to damage from concussion or crushing only (as distinguished from excessive tension) the main and safety conductors may respectively be made of metal of equal ductility; but when it is desired to provide in addition against the effect of ten-

sion the safety-conductor is composed of metal having less ductility than that possessed by the main conductor.

The above-described arrangement may be adopted in connection with cables composed of several conductors, in which case the cable must be provided with at least two safety-conductors. These latter may assume the form of a pair of conductors in the center of the cable, as shown in Fig. 1, or as indicated in Fig. 3, but the most advantageous arrangement of the safety-conductors is shown in Figs. 6 and 7, where one of the safety-conductors, *c*, is in the center of the cable, while the other, *c'*, in the form of a metallic tape, may occupy a position either between the inner main conductor, *a*, and the outer main conductor, *a'*, Fig. 6, or between the outer main conductor, *a'*, and the lead covering *e*, Fig. 7.

The method of connecting a cable such as described with reference to Fig. 1 is illustrated in Fig. 3, D representing the dynamo supplying current to the main circuit H, B the battery supplying current to the safety-circuit S, and A A' the switch device adapted, on the interruption of the safety-circuit, to intercept communication through the main conductor.

Throughout the line all the safety-wires *c*, Fig. 1, are included in one circuit S, to which current is constantly supplied by the battery B, this current being just strong enough to retain the armature A' of the switch or "cut-out" in position for enabling the other or more powerful current to traverse the main circuit H. When the safety-current is interrupted the armature A', being no longer attracted, falls away and instantly effects the interception of the main circuit H. Thus, when a cable of the improved construction, forming the main electric line, is strained to a point threatening it with rupture the safety-wire *c*, being less ductile than the main conductor *a*, breaks, interruption in the main circuit H ensuing before the copper conductor *a* itself breaks.

The method of connecting a cable of the construction hereinbefore referred to with reference to Fig. 2 is illustrated in Fig. 4. As there are in this instance two safety-conductors *c c'*, and consequently two safety-circuits S S', a cut-out A is connected to each of these conductors, current being supplied for both cut-outs by one battery B common to both. In this arrangement upon either of the two safety-wires *c c'* being broken the current is diverted from the main conductor *a* before the latter suffers fracture and protection afforded against sparks being emitted on such fracture taking place.

To provide at once against both kinds of accidents—viz., those due to excessive tension and those due to crushing—a cable constructed in accordance with Fig. 1 may be combined with a special safety-switch, such as shown in Fig. 5. In this figure D designates the dynamo; H, the main circuit; S, the safety-circuit; A, the cut-out or switch; B, a battery, and R a relay provided with double contacts *r r'*, the provision for affording safety coming into operation both when the current is cut off and when it is considerably intensified. The contacts *r r'* of the relay are electrically connected with one pole and the tongue *z* with the other pole of the battery B. The safety-wire *c*, or, in other words, the safety-circuit S, is fed in the manner illustrated in the drawings—*i. e.*, by part of the tension of the main current—and by the aid of a resistance W the safety-current flows through the coils of the relay, and while its power is normal retains the tongue *z* in the intermediate position, overcoming for the purpose the resistance of the usual relay-spring, the battery-circuit being in this position open. If the cable be so far strained that it is about to break, the safety-conductor will in all cases break first. The relay-springs thereupon become released and close the circuit B' of the battery B by causing the tongue *z* to come into contact with the contact-piece *r*, for example, of the relay. The armature A' is thus attracted and the main circuit H interrupted. Should, on the other hand, the cable be crushed and damaged, so that a connection is established between the main conductor *a* and the safety-conductor *c*, an intensified current will pass from H through the safety-conductor S, the coils of the relay will be excited to a greater extent, and the tongue *z* will meet the contact *r'*, the battery-circuit B' thereupon becoming closed, the armature A' attracted, and the main circuit H interrupted, as before.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. An electric cable comprising a main conductor and a safety-conductor, the latter being of such a character as to withstand less tensile strain than the main conductor; so that upon the safety-conductor breaking the current is, by means of suitable switch apparatus, diverted from the main conductor, before the latter breaks, substantially as herein described.

2. An electric cable comprising a main conductor and a safety-conductor, the latter being arranged in such a manner that upon its being forced into contact with the main conductor, the current is, by means of suitable switch apparatus, diverted from the main conductor, substantially as herein described.

3. An electric cable comprising two or more main conductors and two or more safety-conductors, the latter being of such a character as to withstand less tensile strain than the main conductors; so that upon the safety conductor or conductors, which control the switch apparatus, breaking, or being crushed, the current in the main conductors, which is controlled by the switch apparatus, is diverted

from those conductors before the latter break, substantially as herein described.

4. The combination, with an electric cable comprising a main conductor and a safety-conductor conveying independent currents, of a switch A, a relay R, and a resistance W, arranged or operating substantially as described, and whereby, on the safety-conductor being either broken or crushed into contact with the main conductor, the current conveyed by the main conductor is instantly interrupted.

THEODORE GUILLEAUME.

Witnesses:
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SOPHIE NAGEL.