No. 845,051. PATENTED FEB. 26, 1907.

R. VON BROCKDORFF.

ELECTRIC RESISTANCE APPARATUS.

APPLICATION FILED DEC. 6, 1906.

2 SHEETS—SHEET 1.

Fig. 1

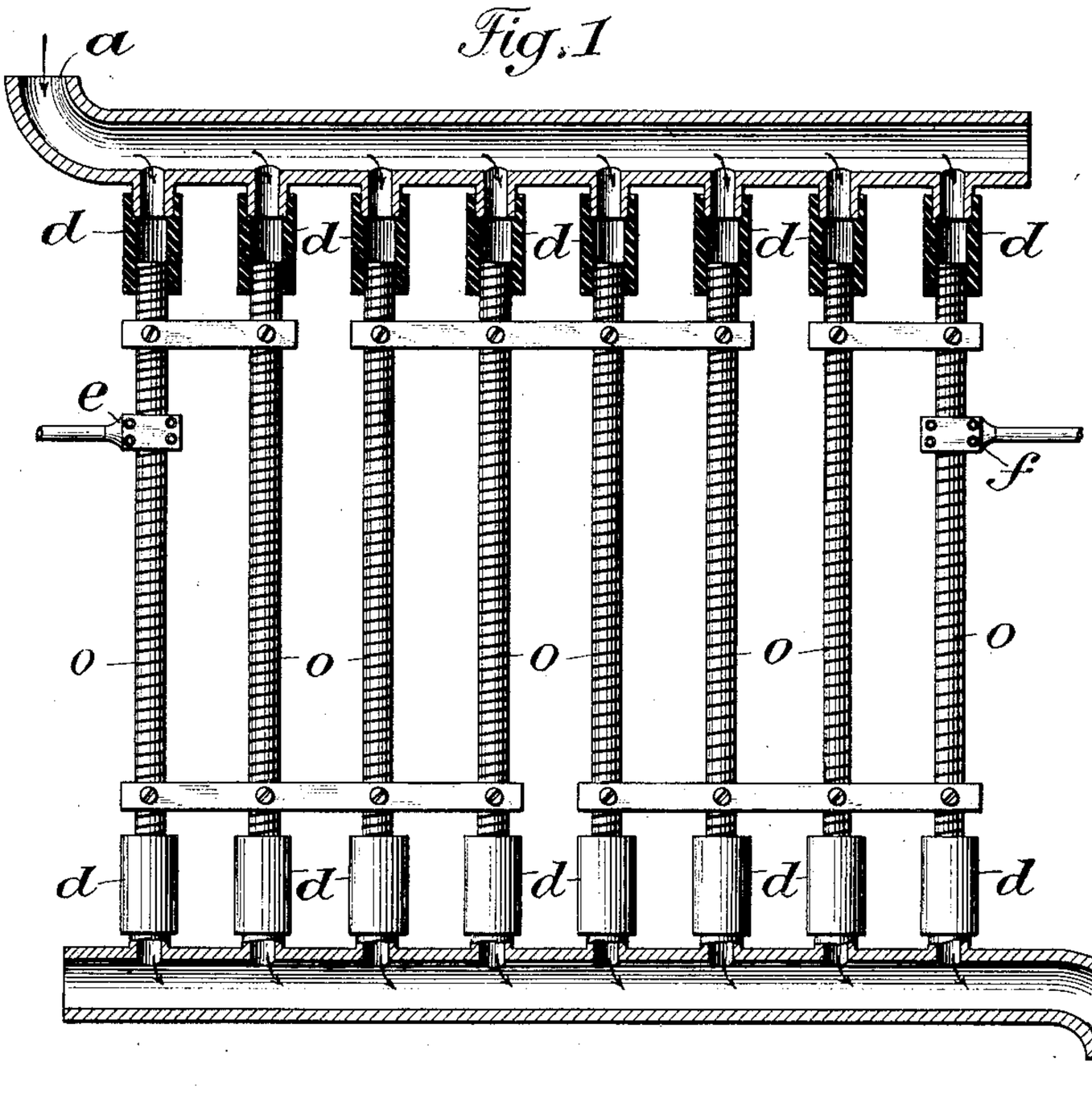
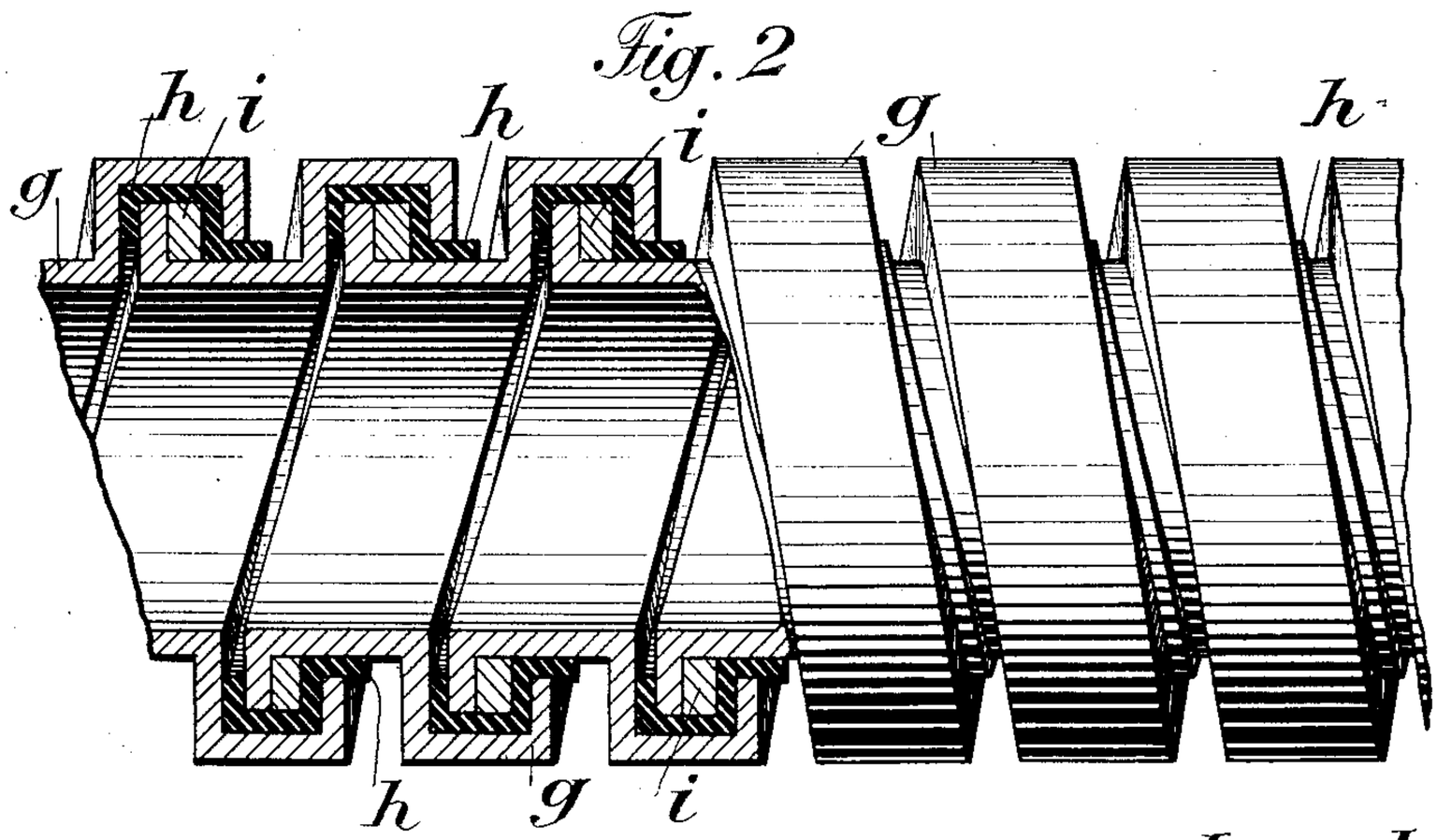


Fig. 2



Witnesses:

Jesse N. Sutton

B. Dommers

Inventor:

Rolf von Brockdorff

by Henry Orth & Co

Att'y.

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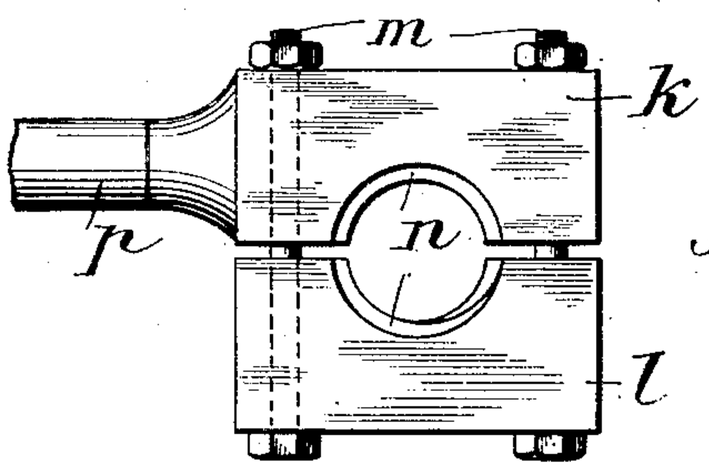

Fig. 3

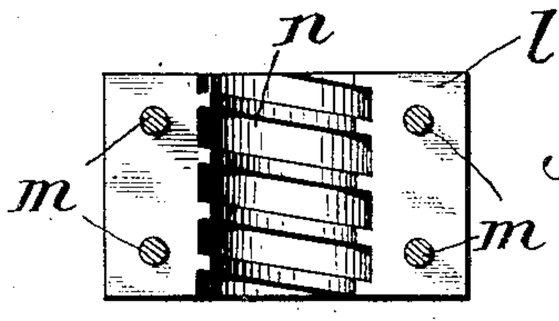

Fig. 4

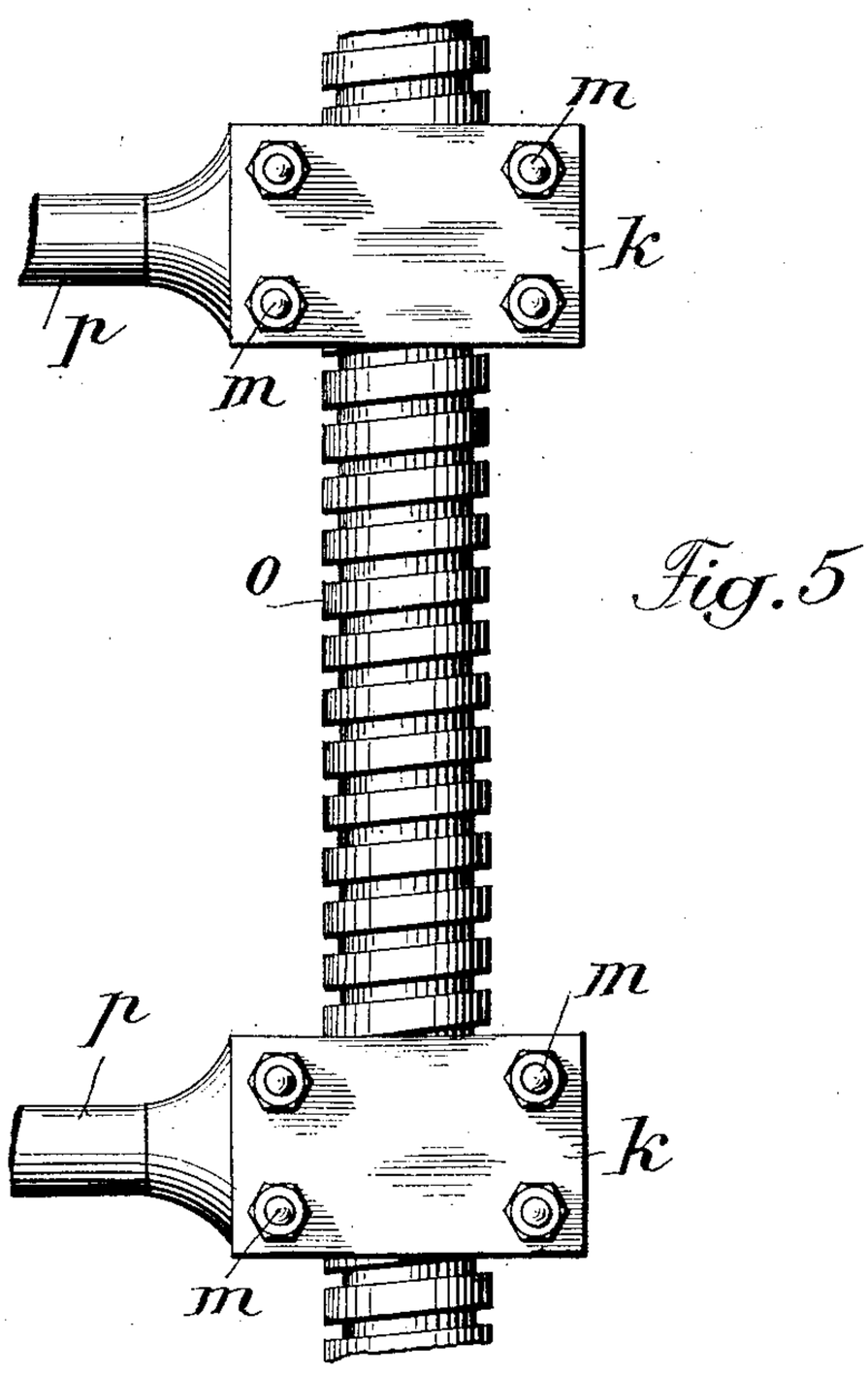

Fig. 5

Witnesses:

Jesse N. Sutton

B. Dommers

Inventor:

Rolf von Brockdorff

by Henry Orth & Co

Atty.

UNITED STATES PATENT OFFICE.

ROLF VON BROCKDORFF, OF BREGENZ, AUSTRIA-HUNGARY.

ELECTRIC-RESISTANCE APPARATUS.

No. 845,051. Specification of Letters Patent. Patented Feb. 26, 1907.

Application filed December 6, 1906. Serial No. 346,590.

To all whom it may concern:

Be it known that I, ROLF VON BROCKDORFF, a subject of the Emperor of Germany, residing at Bregenz, Austria, have invented certain new and useful Improvements in Electric-Resistance Apparatus; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

Electric resistance for converting large quantities of energy into heat are employed as load resistances in test-fields and laboratories and also for starting large motors in the working of electric railways and central stations and for many other purposes. Their permissible load, and therefore also the space they occupy, and their cost are dependent upon the heating of the resistance material. Resistances which only remain inserted for a short time are therefore surrounded with materials having a great capacity for heat, such as oil, sand, or firebrick. Resistances which remain permanently inserted are made with as large a surface as possible in order to facilitate the radiation of heat. Tubular resistances cooled with water have also been constructed. In place of such tubes metallic hose may be employed with great advantage in the construction of resistances, for metallic hose possesses a much greater resistance than tubes of the same material, length, and weight. Owing to the essentially greater surface, moreover, the carrying capacity is also much greater and increases with water cooling still further, since the quantity of heat generated is almost entirely carried away by the water. Thus the carrying capacity depends chiefly upon the quantity of water flowing. With a flow of some ten liters per minute a steel hose of eight millimeters internal diameter and one meter length may be loaded without danger with four hundred amperes at one hundred and twenty-five volts. This property of metallic hose enables extremely compact resistances to be constructed. By the employment of hose of large internal diameter and correspondingly-increased surface and large cross-section or in the event of connection in parallel of such resistance hose-sections quantities of electric energy with very great strengths of current can be converted into heat by the use of long hose or with series connection of the resistance hose-sections, such with high tensions.

In the case of very large permanent loads the water if it should have to run through the entire length of the hose would be unduly heated. In such cases the hose may be subdivided, so that the various parts receive a separate supply of water, while they may be electrically connected in any desired manner.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 is an elevation and part section of a resistance apparatus constructed with the aid of metallic hose. Fig. 2 is a detail view showing on an enlarged scale a portion of a hose-section having electrically-insulated joints. Fig. 3 is a plan of a terminal-clamp which may be employed. Fig. 4 is a section through Fig. 3. Fig. 5 is an elevation, drawn on an enlarged scale, of a portion of one of the hose-sections of Fig. 1 with conductors clamped thereto.

The cooling water enters the resistance apparatus at *a* and flows in the direction of the arrows through the metallic hose-sections *o*, leaving the apparatus again at *b*. The various metallic hose-sections are connected to the inlet and outlet water-pipes by insulating-sleeves *d*. The electric current enters at the terminal *e* and leaves at the terminal *f*. In the drawings the hose-sections are shown connected two in parallel and four such pairs in series. Naturally, however, the manner of connection may be another, according to the particular purpose in question. Thus, for instance, all the hose-sections might equally well be connected in series or all in parallel. Nor is it necessary that the flexible sections be straight. They may be of any suitable form—for example, spirals, if desired. With starting resistances constructed of such sections the water-current may be turned on and cut off automatically by the motion of the starting device, so that the resistances are cooled only so long as the electric current flows through them. In the case of material with high-temperature coefficients the exact regulation may be effected by alteration in the water-supply.

The resistance-sections may be switched by any suitable switching apparatus. When the resistances are high, the hose may be made of some specially suitable material, such as nickeline or Constantan.

In order to obtain a further increase of resistance with these resistance members, which in any case are arranged for a great load, the individual coils of the spirally-wound metal tape of the metallic hose may be completely insulated from each other by an intermediate insulating layer or by an insulating-coating applied to the metal tape, so that the electric current is compelled to flow through the metallic hose in a spiral path. By means of an insulating-coating applied to the metallic tape electrolytic actions may also with certainty be prevented.

Fig. 2 shows in detail a portion of such a metallic hose-section. Between the coils of the metal tape *g* of the metallic hose, packed by gasketing *i*, an insulating-strip *h* is inserted to prevent metallic contact of the various coils.

Figs. 3 and 4 show on an enlarged scale a terminal such as is employed in the apparatus of Fig. 1. The terminal consists, preferably, of two parts, (though more than two parts may be employed, if desired,) which are provided with a recess *n*, whose profile corresponds with that of the metallic hose *o*.

The two parts *k l* serve as jaws and are pressed to the hose by four bolts *m*, Figs. 3 and 4, the coils of the hose fitting exactly into the corresponding recess *n* in the jaws *k l*, whereby thorough contact is insured. Fig. 5 shows two terminals applied to the hose *o*, *p* being the conductors leading to the controller.

The jaws may be naturally pressed to the metallic hose in other manner than that shown, intimate contact between terminal and hose being always insured by like profiles of the two parts. By loosening the jaws and sliding the terminal or screwing it backward and forward in the thread or spirals of the metallic hose the resistances can with rapidity be very accurately adjusted. The outer part of the terminal—that is to say, the part which does not lie against the metallic hose—may be of any shape whatsoever, according as the terminal is intended to connect the hose with a rod, wire, cable, or other conductor.

The terminal-clamp described in view of its practical construction may be very readily applied at any desired part of the resistance member, even although the latter has already been fixed in the resistance apparatus and secured at both ends.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is—

1. In an electric-resistance apparatus, a resistance member in the form of a metallic hose, whose metallic skeleton constitutes the electric-resistance material, substantially as described.

2. In an electric-resistance apparatus, a resistance member consisting of a metallic hose formed of a spirally-wound metal tape, which constitutes the electric-resistance material, the coils of said tape being electrically insulated from each other, substantially as described.

3. In an electric-resistance apparatus, a resistance member consisting of a metallic hose formed of a spirally-wound metal tape, which constitutes the electric-resistance material, the coils of said tape being electrically insulated from each other, in combination with a terminal-clamp comprising jaws recessed to correspond with the profile of the hose, and means for pressing the jaws to the hose, substantially as described.

4. In an electric-resistance apparatus, a resistance member consisting of a metallic hose formed of a spirally-wound metal tape, which constitutes the electric-resistance material, the coils of said tape being electrically insulated from each other, in combination with a terminal-clamp comprising two jaws recessed to correspond with the profile of the hose, and bolts for pressing the jaws and hose together, substantially as described.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

ROLF VON BROCKDORFF.

Witnesses:

ERNST FISCHER,

A. LIEBERKNECHT.