

[54] **APPARATUS FOR UNCOILING WIRE FROM A SPOOL**

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[56] **References Cited**

UNITED STATES PATENTS

2,179,334 11/1939 Keyes.....57/18

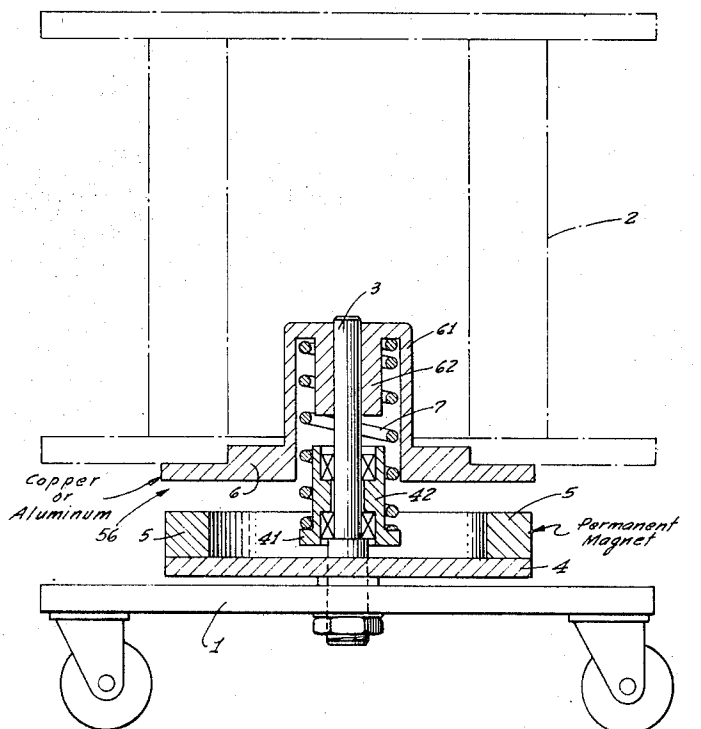
2,365,691 12/1944 Foder.....242/75.51
2,849,194 8/1958 Henning.....242/82

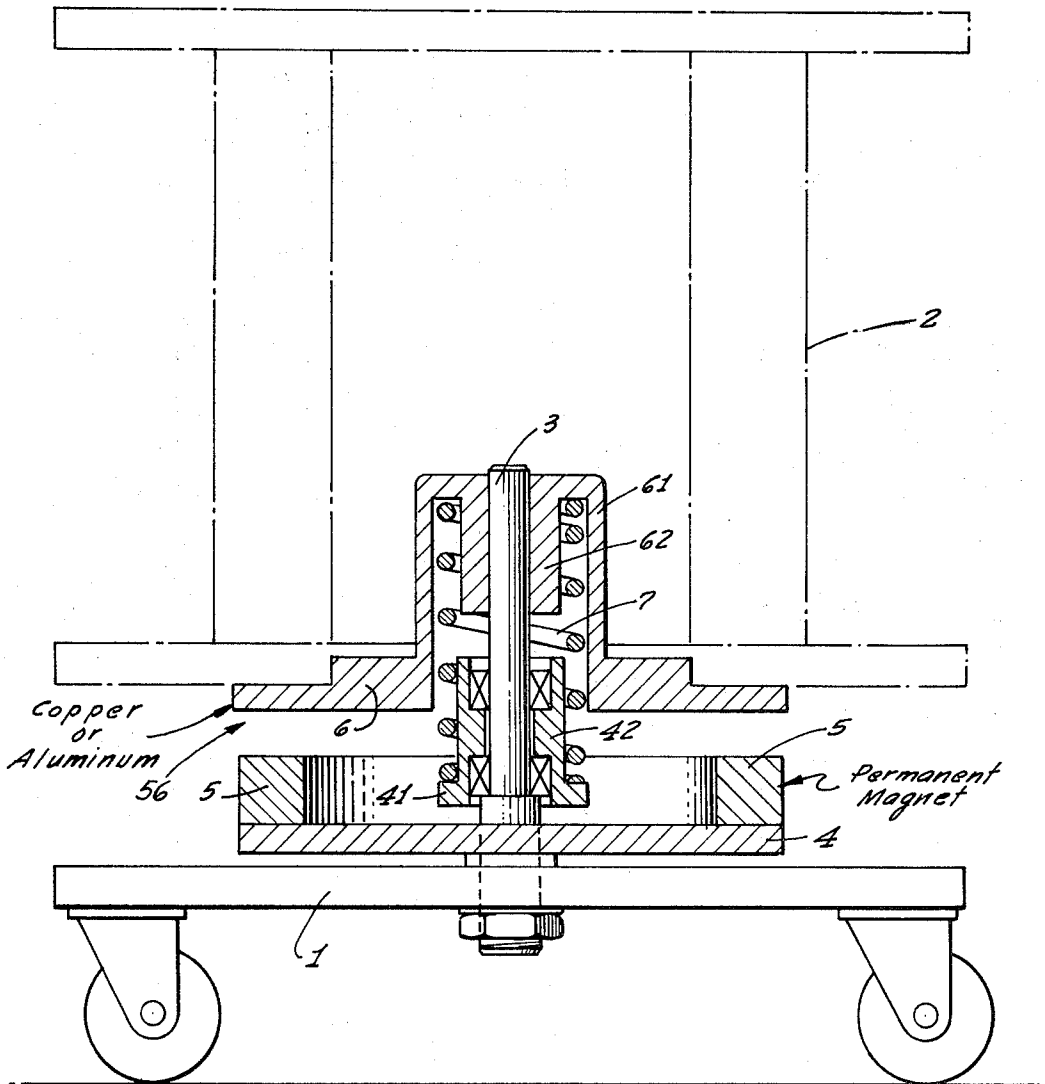
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[57] **ABSTRACT**

In an apparatus for uncoiling wire from a spool at constant speed and tension using an eddy current brake having a magnet and an electrically conductive disk for rotating in the magnetic field as provided by the magnet; for example, the magnet is mounted on a base, and the disk is or is part of the turntable supporting a spool from which wire is to be uncoiled. The turntable is axially spring biased and journalled for rotation about a vertical axis, whereby the effective air gap between the magnet and the disk is determined by resilient reaction of the spring to the weight of the spool. As wire is uncoiled, that weight decreases while the rotational speed of turntable and spool increase so that tension and withdrawal speed of the wire remain constant.

4 Claims, 1 Drawing Figure





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APPARATUS FOR UNCOILING WIRE FROM A SPOOL

The present invention relates to apparatus and equipment for uncoiling a wire from a feed spool at constant speed and for maintaining tension exerted upon that wire likewise constant.

Uncoiling and withdrawal of wire at constant speed and tension is, for example, needed in equipment for insulating wire by enameling or varnishing. The wire is usually insulated by two basic steps. First, wet varnish or enamel is deposited on the wire surface, and subsequently the varnish or enamel is baked onto the wire. The resulting layer provides surface insulation which, of course, must meet particular requirements. For example, the layer must have particular insulating resistance and must have particular breakdown resistance and potential. Additionally, the wire must have predetermined mechanical properties, such as surface hardness, wear and abrasive resistance, stress-strain characteristics, tension module, etc. The layer configuration must be as concentric around the center axis of the wire as possible, so that the various characteristic parameters have no angular variation. Furthermore, the insulating surface film must resist impregnating lacquers and their solvents during a subsequent impregnating process. The insulation must not soften or peel off at the usual operating temperatures to which coils or the like, made from such wire, are exposed during use. The layer must also resist aging to a desired predetermined degree. For example, the wire must maintain elasticity and electrical insulative properties for at least 20,000 to 25,000 hours, and the varnish or enamel film must adhere sufficiently firmly to the wire surface throughout that period.

It is usual to run the wire several times through the same furnace for baking, using reversing pullies, whereby actually prior to each return into the furnace a new varnish or enamel layer is added, each having about 0.002 to 0.010 millimeters. Another manufacturing process uses several furnaces, and the wire passes through them sequentially. This latter method is particularly used when the wire to be enameled or varnished is quite thin. Nevertheless, in both cases there is some tension in the wire as it traverses the processing line.

Tension in the wire is needed for properly introducing the wire into the furnace. Setting up tension requires that the wire be subjected to braking, which is provided usually on the feed and uncoiling equipment for the bare wire. For obtaining the above-mentioned properties of the varnish or enamel film, and particularly in order to maintain uniformity in these properties over the entire length of the continuously produced wire, it is necessary to provide and to maintain braking of the wire at a particular, constant force.

It was found to be of advantage to unwind thin wire from a stationary spool and a take-up device revolves around the spool. For thicker wire, however, turning of the supply drum or feed spool is preferred and has been used in the past. The present invention relates particularly to apparatus, where the spool or drum holding the bare wire rotates during uncoiling. It has to be considered additionally that semi-hard or hard uninsulated wires as supplied on spools have to be annealed (spheroidized) prior to enameling or varnishing. Thus, the

uncoiled wire will traverse an annealing furnace accordingly. If relatively thick and hard uninsulated wire is uncoiled, utilization of rotating take-up devices may lead to difficulties.

As was mentioned above, care has to be taken that wire is taken off the spool or drum at uniform tension. Observations led to the conclusion that eccentricity and imbalance in the mass distribution of the supply spool results in tension variations which propagate all the way to the take-up spool onto which the enameled or varnished wire is wound. These tension variations can be suppressed by winding the wire onto a drum temporarily and taking the loops off the drum shortly thereafter. Also, a change in direction of the propagation and withdrawal path of the wire eliminates such variation in tension. Of course, in either case, the coiling process suffers. It is particularly noticeable that even minute, oscillatory speed variations in the wire and vibrations thereof cause also (spatially) periodic variations in the thickness of varnish or enamel. These variations are indeed minute, but it is believed that some of the "unexplainable" deficiencies and breakdown of equipment using such wire, and which could be traced to a localized reduction in wire quality, have their source in these minute speed variations and oscillations.

In the past it has been attempted to maintain constant tension in the wire by means of mechanically retarding uncoiling of the bare wire. Brakes have been used here for applying adjustable braking pressure to the rotating coil or to the turning spindle thereof. Also, a braking ribbon has been used, whose braking effect on the wire uncoiling device is controlled by varying the tension in that ribbon. All these mechanically operating braking systems, as acting on the wire feed and uncoiling device, depend more or less on production of friction as between the brake and a moving part of the uncoiling device. These brakes have to be adjusted from time to time, usually manually, and therefore, they are rather inaccurate, so that their employment in varnishing equipment as described, is unsuitable, and the varnish or enamel layer will not have sufficiently homogenic properties.

Of course, in addition, the wire has to be taken up at a constant speed, and here it has to be taken into consideration that the feed spool will increase its rotational speed as uncoiling progresses. If the braking effect is speed dependent per se, and that is true to some extent for all friction brakes, speed dependency of braking must be offset. In particular, pressure force exerted by the brake upon a moving part of the spool has to be adjusted, for example, manually, so as to maintain a constant relation between braking and pulling forces for the wire withdrawal. It was found to be very difficult, time-consuming and unreliable, to provide for such variable braking effort. The difficulties are compounded in case large numbers of individual wires are produced, varnished etc., and combined, e.g., by stranding. This requires a constant pay rate for each wire.

It should be emphasized that present day technology readily permits construction of any kind of controlled brake systems, using many condition sensors, feeding, e.g., their electrical outputs to analog or digital processing circuitry and providing power output for

braking at practically any desired degree of accuracy. However, it is common knowledge that reliability of such apparatus declines with increasing complexity, though redundancy may offset such unreliability to some extent. Needless to say, however, that such apparatus is expensive and adds significantly to cost and maintenance of an uncoiler. There is, therefore, a great need for a simple braking equipment without, however, compromising reliability.

It is an object of the present invention to provide a more suitable tensioning and speed control for wire as uncoiled from a spool, or the like, by means of braking equipment that automatically adjusts to a change in condition. In accordance with the preferred embodiment of the present invention, an eddy current brake is provided, which is known per se, but presently the brake is to have a variable air gap so as to permit variation in the braking force. For constant air gap, the braking effort of an eddy current brake increases with relative rotational speed of magnetizing part and conductive element of the brake in which eddy current is induced. However, widening the air gap reduces braking force. Particularly, the air gap width is determined by balance or equilibrium condition (on a quasistationary basis) between, e.g., a spring force and the weight of the spool from which wire is uncoiled. The gap widens as the weight of the spool decreases, offsetting the increasing magnetic interaction due to speed increase.

More particularly, use has been made here of the fact that a spool from which wire is uncoiled at a constant speed, will not only increase its rotational speed as layer after layer of the wire is taken off, but also, the weight of the spool decreases. The decrease in weight can be used as a criterium for the reduction in coil or winding radius. It is this reduction in coil radius which is directly responsible for the increase in rotational (angular) speed of the spool for constant (peripheral) withdrawal speed of the wire. On the other hand, weight decrease may operate directly for gap width control. Therefore, as a direct consequence of uncoiling, there occur braking force increasing and decreasing phenomena; braking increases with rotational speed, braking decreases as the spool becomes lighter and the gap in the eddy current brake increases. Upon adjustment and selection of the determining parameters, the braking force will stay constant.

The spool from which to uncoil wire has vertical position and is preferably seated on a turntable that is journaled on a vertical shaft extending from a stationary base. A spring acts in axial direction on spool and turntable, against the weight thereof. The stationary part of an eddy current brake (e.g. the magnetizing component) is also disposed on the base, while the turntable serves as the rotating part (armature) in which eddy current is induced upon crossing the field lines provided by the magnetizing part. As wire is uncoiled from the spool, the rotational speed thereof increases, so that magnetic retardation of the turntable increases. However, the weight of the spool decreases; accordingly, the spring biases relaxes so as to lift the turntable higher above the magnetizing part of the brake. The air gap increases, so that, in the balance, the braking force remains constant to obtain constant payout speed and also constant tension in the wire.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention, it is believed that the invention, the objects and features of the invention and further objects, features and advantages thereof will be better understood from the following description taken in connection with the accompanying drawings in which:

The FIGURE illustrates somewhat schematically a cross section view of an uncoiling device with a brake constructed in accordance with the preferred embodiment of the present invention.

Proceeding to the detailed description of the drawings, there is provided a base 1 constructed as a carriage and serving as basic support element for a spool 2 that may contain uninsulated, bare wire. A shaft or axle 3 is mounted on and bolted to carriage 1 in vertical position. Next there is provided an eddy current brake having a stationary support plate 4, likewise mounted on carriage 1. The stationary part of the eddy current brake includes particularly an annularly shaped permanent magnet 5.

Spool 2 is indicated by the dash-dot lines and wire wound thereon is not included, but one can readily see that spool 2 is provided for holding many layers of coiled wire. A turntable 6 is provided as immediate support for spool 2. Turntable 6 is made of aluminum or copper, i.e., it has low electrical resistance as well as low magnetic permeability, so as to serve as co-acting, rotating part of the body current brake. Turntable 6 has a lower, flat side facing magnet 5 axially across an air gap 56. The upper part of turntable 6 is provided with annular steps, only two of them are shown in the drawing, but more could be provided. These steps permit placement of different size spools on the same turntable. For each spool size there is provided a short insert to frictionally hold and receive the spool.

The turntable 6 is journaled on shaft 3. In particular, table 6 has a cup-shaped hub portion 61 which is provided with a short internal sleeve 62, rotatably and slideably receiving the upper end of shaft 3. The hub 61 receives a spring 7 and is, in fact, carried by the spring. The lower end of spring 7 bears against a flange 41 of a bearing element or sleeve 42 that is capable of rotation but has fixed axial position on shaft 3. Position of stationary and rotating parts of the eddy current brake can be exchanged in that the permanent magnet is attached to the turntable 6, and base 4 is a co-acting armature.

The brake as shown in the drawing operates as follows. A full spool is seated on turntable 6, and its weight compresses spring 7 significantly, so that the balance of spring compression and weight of the spool establishes minimum distance between turntable and magnet, i.e., the width of air gap 56 has minimum value for the now beginning run. A very heavy spool may cause turntable 6 to be seated on the magnet in engagement therewith, which is not desirable as the turntable should not abrasively slide over the magnet during uncoiling. It should be noted, however, that there is no danger that the turntable may stick to the magnet, as aluminum or copper cannot be magnetized.

The varnishing or enameling equipment draws wire for uncoiling from the spool, and the resulting tension in the wire sets spool and turntable 6 into motion. Therefore, turntable 6 with spool 2 turns on shaft 3, but

at relative low angular speed as the winding radius of the full spool is quite large. Constant tension is exerted upon the uncoiling wire, if the wire pulling force is constant. Additionally, the eddy current brake provides for constant braking force, as the electrically conductive turntable rotates in the axial field of permanent magnet 5. This rotation in and across a magnetic field sets up eddy currents in the turntable, tending to retard its rotating motion. The width dimension of air gap 56 is directly related to the braking force provided upon turntable spool and wire. A washer may be used to adjust the equilibrium position of the turntable for a particular initial weight of a spool. That washer may be interposed between spring 7 and one of the two surfaces against which the spring bears.

Now, as wire is uncoiled from rotating spool 2, two directly related phenomena occur. On one hand, the rotational (angular) speed for constant withdrawal speed of the wire increases in direct proportion to the reducing winding radius of the wire as uncoiled from the spool. For constant width of air gap 56, an increase in rotational speed results in an increase in the inductive interaction between the magnet field of permanent magnet 5 and the opposing magnetic field as resulting from the eddy currents in the turntable, because the intensity of these currents increase with speed, so that actually the braking effect would continuously increase as wire is uncoiled.

Now, we have to consider the second effect; due to wire payout, the coil loses weight at a constant rate. Therefore, the resilient equilibrium is disturbed and, actually, quasi-stationary conditions cause expanding spring 7 to uniformly lift turntable and spool upon this gradual reduction in weight. Therefore, air gap 56 widens, and the magnetic field density, as traversed by the rotating turntable, reduces proportionally in inverse relationship to the air gap or directly proportionally to the weight. This widening of the air gap reduces braking.

Summarizing the foregoing, the rotational speed of the turntable relative to the stationary magnet and, therefore, the brake effect increases proportionally to the inverse of a (radial) length dimension, while analogously the magnetic field becomes weaker, also inversely proportional to a (axial) length dimension due to the increase in size of the air gap. One can, therefor, see that upon proper proportioning and dimensioning of the various components, these parameters can be adjusted so that, in fact, the brake force remains constant; the tension in the wire will, thus, remain constant and that, in turn, ensures constant uncoiling speed of the wire itself.

It can readily be seen that numerous parameters are available here to obtain constant braking force on a dynamic basis by mutually offsetting variations. Aside from the choice in material for magnet and turntable, the thickness of the latter is a parameter; the operating range for the magnetic field can be adjusted by interpositioning of washers; spring force is still another

parameter that can be suitably selected or adjusted through selection and bias. Weight can be added to the turntable for loading and bias modification. Spring bias control and weight adjustment are particularly useful for adapting the uncoiler, e.g., to different spool or drum weights and to take different wire material into consideration (copper or aluminum).

The following point should be noted. As a layer of coiled wire is unwound, the weight is reduced but the radius of uncoiling remains constant. However, the number of layers on the spool is usually so large that the relative weight reduction experienced by removal of just one layer is so small to have practically no effect on the balance conditions. Therefore, the relationships between coiling radius and weight is based on averaging, but this instantaneous and temporary deviation from average is insignificantly small.

The invention is not limited to the embodiments described above but all changes and modifications thereof not constituting departures from the spirit and scope of the invention are intended to be included.

I claim:

1. In an apparatus for uncoiling wire from a spool at constant speed and tension, which includes a base, a spool support means, and journalling means on the base for journalling the support means on the base and relative to a vertical axis, comprising:

an eddy current brake including magnet means and electrically conductive means, provided in spaced-apart relation on the axis with an air gap in between and further provided for relative rotation on the axis in the magnetic field as provided by the magnet means, whereby the rotation as between the magnet means and the conductive means is retarded at magnitude depending upon the distance in axial direction as between magnet means and conductive means across the air gap;

one of the magnet means and of the electrically conductive means being mounted on the base,

the other one of the magnet means and of the electrically conductive means being on or a part of the spool support means; and

means including resilient means for balancing the support means against the weight of the spool thereon and as journalled for rotation about the axis, so that the distance between the magnet means and the conductive means is dependent upon the resilient reaction of the resilient means to the weight of the spool, and the retarding force effective between the conductive means and the magnet means gradually diminishes as wire is uncoiled from the spool on the support means.

2. Apparatus as in claim 1, the spool support means being a turntable serving itself as electrically conductive means, the magnet means mounted on the base.

3. Apparatus as in claim 2, the turntable being made of aluminum or copper.

4. Apparatus as in claim 1, the second means having steps for accommodating different size spools.

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