Aug. 22, 1961 G. MEINSHAUSEN 2,997,249

LAYING ARM FOR WIRE COILING DEVICE

Filed March 13, 1958 2 Sheets-Sheet 1

Fig. 1

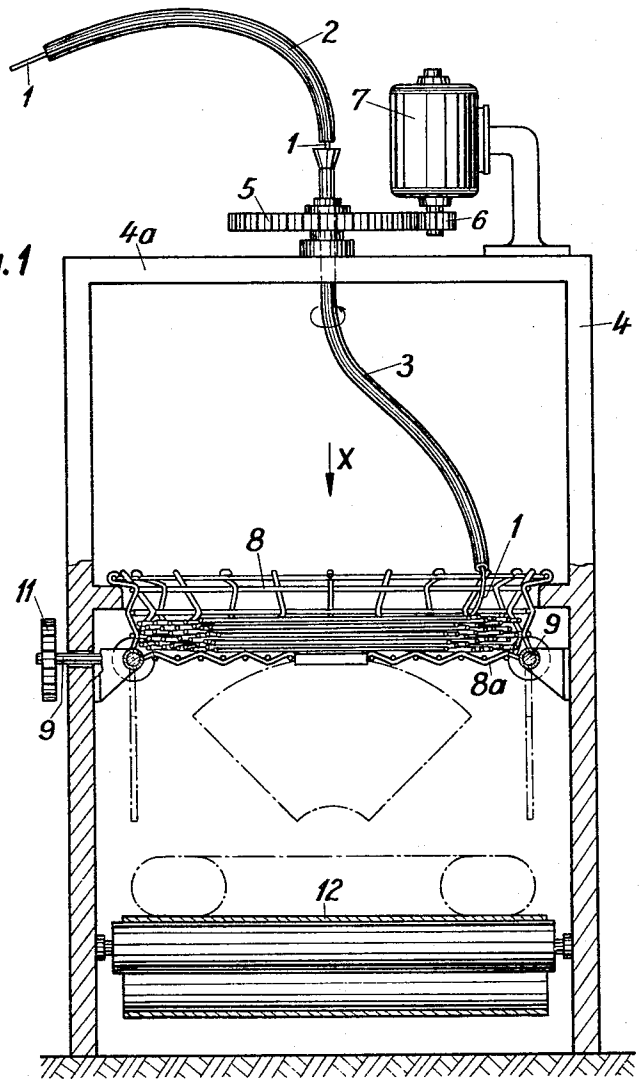
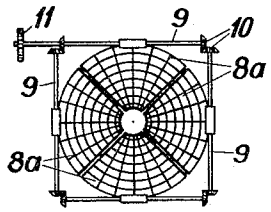


Fig. 2



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Filed March 13, 1958 2 Sheets-Sheet 2

Fig. 3

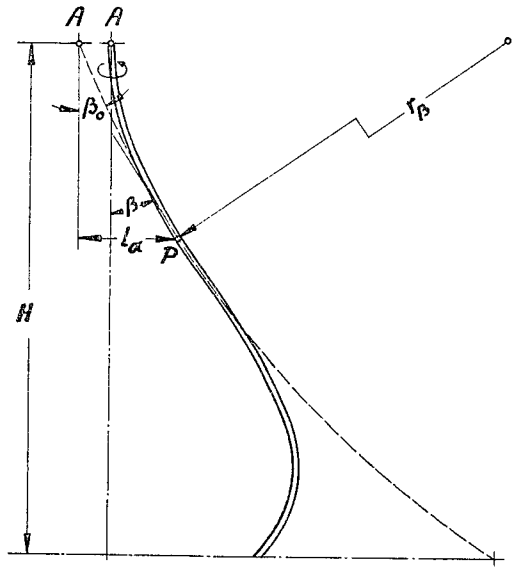
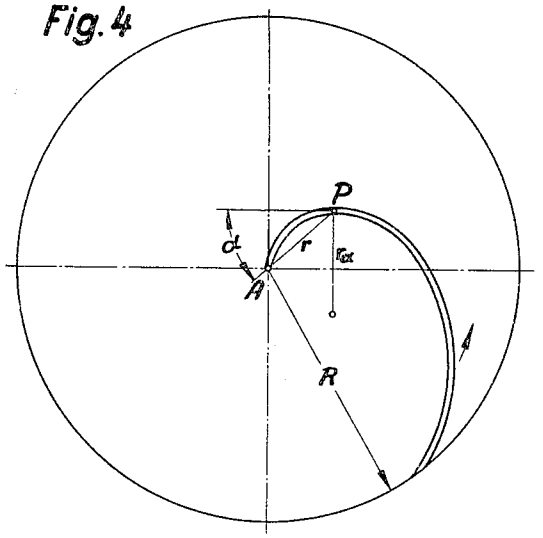


Fig. 4



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LAYING ARM FOR WIRE COILING DEVICE

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1 Claim. (Cl. 242—82)

The invention relates to a wire coiling device in which the wire emerging from a train of rolls is fed axially of the device into one end of a curved laying arm constituting a guide for the wire and from the other end of which the wire is delivered for coiling. The peripheral speed of the laying arm at its exit end corresponds at least approximately to the speed of entry of the wire and therefore of its travel through the laying arm.

As the result of the rotation of the laying arm, the wire therein is pressed against its wall so that there is friction on passage of the wire between the wire and said wall, the friction increasing with the speed of rotation of the laying arm. This can easily lead to compression of the wire within the laying arm, with the result that its front end becomes bent and blocks the passage for the wire, which can cause serious delays in production.

If the entering end of the wire becomes bent and causes a stoppage, the supply of wire from the roll train must first of all be interrupted and this is usually effected by a rotary knife, generally automatically operated, which cuts the wire emerging from the rolls into lengths which can be handled. The piece of wire left in the guides and the laying arm must then be withdrawn and cut or coiled. Coiling is therefore interrupted at least during the performance of these operations, which require considerable effort and time.

The speed of revolution of the laying arm is higher, the thinner the wire to be coiled. As the acceleration forces in the coiler increase rapidly with increasing rotational speed and the stiffness of the wire decreases rapidly with the reduction in its diameter, the possibility of coiling thin wires at high speeds is limited by the friction of the wire in the laying arm. This frictional resistance is decisive in regard to the entering end of the wire.

In the known laying mechanisms there is, moreover, rapid wear of the laying arm as the result of the friction between it and the wire, which involves costs for replacement of the laying arm and also loss of production.

The object of the invention is to provide a laying mechanism which avoids the above disadvantages by arranging that the center line of the laying arm deviates initially from the direction of the axis of rotation by a desired and predetermined angle β_0 and thereafter follows such a curved path that the radial distance of the individual points of the center line from the axis of rotation does not depart by more than $0.1r$ from a three-dimensional curve which fulfils the conditions:

$$r_\beta = \frac{R^2}{r \cdot \cos\alpha \cdot \cos\beta}$$

and

$$r_\alpha = \frac{R^2 \cdot \sin^2\beta}{2R \cdot \sin\beta - r \cdot \sin\alpha}$$

where

r is the radial distance of any desired point of the three-dimensional curve from the axis of rotation,

R is the mean radius of the coil of wire,

α is the angle between the tangent at any desired point on the projection of the three-dimensional curve on a plane perpendicular to the axis of rotation and the perpendicular from this point to the axis of rotation,

β is the angle between the axis of rotation and the tangent at any desired point on the projection of the three-dimensional curve on a plane parallel to the axis of rotation and tangential to the three-dimensional curve at the point P,

r_α is the radius of curvature at any desired point of the projection of the three-dimensional curve on a plane perpendicular to axis of rotation, and

r_β is the radius of curvature at any desired point of the projection of the three-dimensional curve on a plane parallel to the axis of rotation and tangential to the three-dimensional curve.

As in known wire coilers the laying arm is initially bent at a desired angle determined by the relation between the constructional height of the laying arm and the mean radius of the coil. Then follows, according to the invention, shaping of the laying arm according to the above mentioned curved path of its center line. The wire, particularly its entering end, can follow in the laying arm a path such that it is subject to no forces, pressing it against the inner wall of the laying arm, if this path corresponds to the above-mentioned three-dimensional curve which, starting from a given initial angle hereinafter termed β_0 and a given mean radius R of the coil of wire, can be calculated accurately and without regard to the speed of the coiler. If the laying arm is shaped such that its center line does not depart from the three-dimensional curve so calculated by more than mentioned above it has been found in practice that the forces then pressing the wire against the inner wall of the laying arm remain within reasonable limits.

Due to the almost complete avoidance of frictional forces, the apparatus according to the invention has the further advantage that very high coiling speeds can be used. These in the case of thin wires can greatly exceed the speeds hitherto possible. It may also be mentioned that the gravitational force of the wire in the laying arm is vanishingly small in comparison with the other forces acting during rotation of the laying arm, in particular the centrifugal force, and can therefore be neglected.

In the accompanying drawings is shown an embodiment of the invention applied to a so-called Edenborn wire coiling device provided with a laying arm constituting a guide channel for the wire. In the drawings:

FIG. 1 shows the coiling device, in side elevation, partly in section,

FIG. 2 shows part of the coiling device on a smaller scale, seen looking in the direction of the arrow X in FIG, 1,

FIG. 3 is an elevation of the three-dimensional curve required for the laying arm according to the invention, and

FIG. 4 is a plan view of the three-dimensional curve.

The wire **1** emerging e.g. from a rolling mill passes through a tubular guide **2** into a tubular laying arm **3**. The upper part of the tube **3** is rectilinear and extends in a direction perpendicular to the upper cross member **4***a* of a frame **4**. Fixedly mounted on the tube **3** is a gear wheel **5** meshing with a pinion **6**. The pinion is fixed to the shaft of a motor **7** also mounted on the cross member **4***a*.

The lower part of the tube **3** is so bent that the wire fed through the tube and emerging at its lower end is laid in a circular path to form a coil. A basket **8** is provided in the frame **4** beneath the tube **3** to receive this coil, its bottom being circular and constituted by four sectors **8***a* pivoted on horizontal axes. These sectors are arranged as shown in FIG. 2 and each is fastened to a shaft **9** journalled in the frame **4**. The four shafts form a square and are connected by bevel gears **10**. One of the shafts extends beyond the bevel gears and carries a gear wheel **11** which can be driven from a suitable source, so that after formation of a coil of wire the sectors **8***a* can be

moved simultaneously downwards. Beneath the basket runs an endless band 12, which receives the coils of wire and transports them slowly, for the purpose of slow cooling, to a place of storage.

The curve shown in FIG. 3 is an elevation of a three-dimensional curve, representing the curvature of the tube 3, projected on to a plane parallel to the axis of rotation of the tube. This plane touches the three-dimensional curve at the point P. The height of the three-dimensional curve is represented by H in FIG. 3. The angle β_0 is the starting angle of the three-dimensional curve and it thereafter follows a direction dependent on the desired relation between the height H and the diameter, 2R, of the coil of wire. After determination of the angle β_0 and the initial deviation from this angle, the calculation of the three-dimensional curve is commenced at the point A which lies on the axis of rotation. The curve shown in dash lines in FIG. 3 is the development of the three-dimensional curve in a plane parallel to the axis of rotation. This development and the projection, shown in FIG. 4, of the three-dimensional curve on a plane perpendicular to the axis of rotation are next drawn. Taking the initial values β_0, $\alpha=0°$ and $r=0$, the radii of curvature r_α and r_β are calculated for the point A of the three-dimensional curve from the appropriate equations. The initial part of the three-dimensional curve can then be drawn.

The values for the radii of curvature for the next curved portion are obtained from the values of β, α and r at the end of the first portion of the curve. Care should however be taken that the distance of the desired point P of the three-dimensional curve from the axis of rotation in the development, which is indicated by l_a in FIG. 3 is equal to the length in FIG. 4 of the projected portion of the three-dimensional curve between the points A and P.

In this way the development in FIG. 3 and the projection in FIG. 4 are obtained within desired limits of accuracy. The three-dimensional curve itself can easily be determined from these two curves. If the resulting height H of the three-dimensional curve is too high it is necessary to start with a larger initial angle β_0, while if H is too small, β_0 must be chosen smaller.

The three-dimensional curve gives the shape of the laying arm 3 and therefore the path which the wire must follow within the laying device. To avoid too sudden a change in direction at the starting angle β_0, the laying arm can include a transfer portion which guides the wire gradually from the axial direction and through the angle β_0.

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

A wire coiling device in which the wire is fed axially of the device into one end of a rotating curved laying arm constituting a guide for the wire and from the other end of which the wire is delivered for coiling, the center line of the laying arm deviating initially from the direction of the axis of rotation by a desired and predetermined angle and thereafter following such a curved path that the radial distance of the individual points of the center line from the axis of rotation does not depart by more than $0.1r$ from a three-dimensional curve which fulfils the conditions:

$$r_\beta = \frac{R^2}{r \cdot \cos\alpha \cdot \cos\beta}$$

and

$$r_\alpha = \frac{R^2 \cdot \sin^2\beta}{2R \cdot \sin\beta - r \cdot \sin\alpha}$$

where

r is the radial distance of any desired point P of the three-dimensional curve from the axis of rotation,

R is the mean radius of the coil of wire,

α is the angle between the tangent at any desired point P on the projection of the three-dimensional curve on a plane perpendicular to the axis of rotation and the perpendicular from this point to the axis of rotation,

β is the angle between the axis of rotation and the tangent at any desired point P to the projection of the three-dimensional curve on a plane parallel to the axis of rotation and tangential to the three-dimensional curve at the point P,

r_α is the radius of curvature at any desired point P of the projection of the three-dimensional curve on a plane perpendicular to the axis of rotation, and

r_β is the radius of curvature at any desired point P of the projection of the three-dimensional curve on a plane parallel to the axis of rotation and tangential to the three-dimensional curve.

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