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DEVICE FOR REDUCING THICKNESS OF THIN SHEET MATERIAL

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Fig. 1.

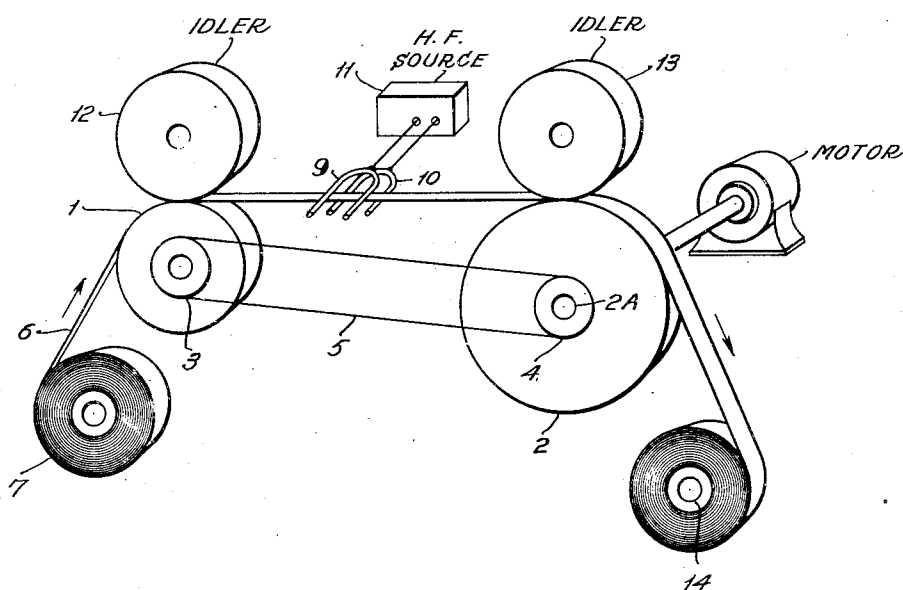
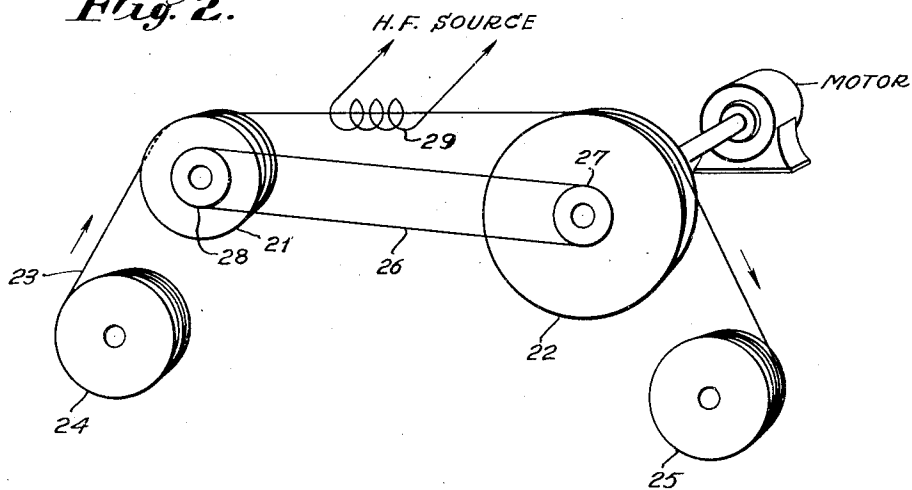


Fig. 2.



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DEVICE FOR REDUCING THICKNESS OF
THIN SHEET MATERIAL

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5 Claims. (Cl. 219-1)

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This invention relates to apparatus and means for reducing the thickness of thin sheet material, and for reducing the diameter of wires.

An object of this invention is to provide a machine which will efficiently and uniformly reduce the thickness of thin sheet material, such as sheet steel for transformer laminations, without the use of precision rolls.

Another object of this invention is to provide means for reducing the diameter of wires without the use of precision dies.

A feature of the invention is a novel arrangement of a high frequency induction heating device and two interlinked moving elements, movement of which automatically stretches the material by a predetermined amount. These interlinked elements may, for example, be rotating drums having different peripheral speeds for stretching the sheet stock or wires.

As an example of a need for, and application of the invention, it is noted that, in the development of pulse transformers for use in radar and pulse communication systems there is a great need for extremely thin laminations of magnetic material. Thin iron laminations, or ribbons, in the order of .001" thick have not been obtainable in ordinary trade channels.

Objections to the manufacturing of extremely thin laminations are that they are hard to roll to such small dimensions. They require extreme precision in roller dimensions and finish and the laminations or ribbons are hard to handle without wrinkling after they are rolled. Furthermore, because of the thinness of the sheet material, a given weight and volume of core material occupies the time of the rolling equipment in inverse proportion to the thickness of the sheet material.

An outstanding advantage of the invention is that it permits adjustment of the dimensions of laminated materials which, at present, cannot be handled satisfactorily by rolling or drawing because of differences in the hardness and viscosity of the laminated materials.

It should be understood that the principle of this invention is applicable to all sorts of stretching or drawing operations on a wide variety of materials, including metals, plastics, etc.

This invention will best be understood by referring to the accompanying drawing in which:

Fig. 1 is a perspective view of the device of the invention as applied to reducing the thickness of thin sheet material, and

Fig. 2 is a perspective view of a device of the invention for reducing the diameter of wires.

Referring now to Fig. 1 of the drawing, to accomplish the reduction of the thickness dimension of sheet material a pair of traction drums 1 and 2 are supported from a common base, not shown. Sheet stock material 6 from a reel 7

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is passed over the two drums 1 and 2 of different diameters which are coupled together by means of sprockets 3 and 4 and chain 5, or suitable gears, the arrangement of coupling or gearing being such as to provide a fixed ratio of revolutions per unit of time between drums 1 and 2. The ratio of speed of rotation and the diameters of the drums determines the amount of stretching of the material and the reduction in thickness. Prevention of any slippage of the sheet material, as it passes over the drums 1 and 2, is maintained by means of the idler rollers 12 and 13.

In the operation of the device of this invention, the drums 1 and 2 as coupled together, are subject to a more or less constant torque, from the power source driving shaft 2a, which tries to stretch the material. If the torque is great enough the material may be stretched cold but for the present example it is assumed that the torque is so adjusted that there is no rotation of the drums and no stretching if the material is cold. A portion of the sheet material, at a point between drums 1 and 2, is now subjected to heating by any suitable means in this example by high frequency induction. The high frequency power is applied to electrodes such as the radio frequency coupling devices 9 and 10 from source 11. The frequency from source 11 is intended to be above 20,000 cycles per second. This high frequency power will raise the temperature of a portion of the material to or beyond the softening or annealing temperature. By this arrangement the metal strip material is uniformly heated by radio frequency induction in a radio frequency field derived from an oscillator 11 which may have a frequency of approximately 1 megacycle to heat the metal strip to a temperature range of 1,000° F. to about 1,500° F. As soon as the proper temperature is reached the drums 1 and 2, which before could not move in response to the torque without stretching the material, will begin to move as the heated material softens and stretches. It is to be noted that the drums cannot turn without stretching the material and the material cannot stretch until it has reached a softening temperature. Therefore, as heat is applied and the material reaches the softening temperature the drums rotate automatically in response to the applied torque but always at a rate such that the hottest part of the material is at the softening temperature. If the material is not hot enough the movement slows down until it is hot enough while, on the other hand, if it is too hot the movement speeds up until it is cooler, because of shorter time of exposure to heating. The rate of motion or stretching is automatically controlled by the rate of heating and results in uniform working on stretching of the material. The apparatus assembly is one which controls

its own speed of operation, to match the heating power input, without the need for any complicated control system. The degree of stretch of the material, or percent elongation, is of course determined by the ratio of peripheral motions of the drums, which are linked together so that the peripheral motions are in a constant ratio. Thus, if the peripheral motion of drum 2 is twice that of drum 1, in Fig. 1, then the elongation of the material will be two to one.

Preferably the material, as it comes from the machine, is wound directly onto core forms to make the cores of the transformers. Spool 14 represents either the transformer core material being wound to form a core or storage spools on which the material is wound for rewinding or other use later.

Referring now to Fig. 2, the application of the invention as applied to drawing wire to a smaller diameter is shown. A wire 23 of some stock diameter, wound on spool 24, is drawn over drums 21 and 22, which are somewhat concave on their outer cylindrical surface, in the manner usual to drawing operations, that is three or four turns of wire around each drum. Drums 21 and 22 are coupled together by means of a chain 26 and sprockets 27 and 28 in the same manner as in Fig. 1, and torque is applied to the shaft of drum 22. High radio frequency induction or another suitable form of heating is applied by drawing the wire through a radio frequency coupling coil or work coil located at a point 29. The radio frequency coil connects to a source of high frequency similar to that of source 11 mentioned above. The wire is thus heated between the drums and the rate of motion of the wire is automatically controlled by the rate of heating.

An advantage of the system of this invention is that the thickness of the finished material is automatically held to the same percentage of tolerance as was obtained in the original stock material and the necessity for extremely close calculation and control of roll dimensions and precision of fine dies as now required to roll very thin laminations or draw fine wires is avoided.

I contemplate, besides chains and gears, the use of adjustable ratio transmissions of which standard types are available in the market, for coupling the drums together. In this case any ratio of thickness or diameter reduction is obtainable on a moment's notice, by mere adjustment of the transmission ratio. Such an arrangement can be of great value in transformer manufacturing plants and other establishments where standard thicknesses and diameters are not adequate to meet all the required conditions of design and for which special drawing and rolling operations are now required.

In the preparation of thin laminations of magnetic material, it has been found that the permeability of the material is substantially greater in the direction of working than in other directions. This increase of permeability in the lengthwise direction will be even greater in material prepared by the present process than it is in material prepared by rolling and drawing operations of the prior art.

Also the stretching process will have a beneficial effect upon the mechanical strength of some materials.

The process and machine of this invention are also applicable to nonmetallic plastic materials, as for example, in the manufacturing of some light polarizing materials a stretching process is used to suitably orient submicroscopic light po-

larizing crystals. This invention is well adapted to performing such a stretching operation.

Likewise the process may be used in producing thin sheets and fibers of thermoplastic materials of all kinds, such as are used as coverings and fabrics, cords, etc.

What I claim is:

1. A device for reducing the thickness of thin sheet material, comprising a plurality of rotatable drums for working and stretching the thin sheet material, said drums having different diameters, means to rotate said drums together to produce a ratio of peripheral speeds having a value greater than one, a source of radio frequency power, a radio frequency heating device connected to said radio frequency source and having electrodes disposed above and below the plane in which the thin sheet material is adapted to pass to raise the temperature beyond the annealing temperature thereof, whereby the thin sheet material running over said drums is stretched, in a fixed ratio when the drums rotate.

2. A radio frequency heating device for reducing the thickness of thin sheet material, comprising two rotatable drums for working and stretching said thin sheet material, each of said drums being operated together with different peripheral speeds and maintained at a substantially constant torque, operating means including a sprocket and chain device to rotate said drums, a source of radio frequency, a pair of radio frequency electrodes connected to said radio frequency source, one of said electrodes being located above the thin sheet material and the other electrode being located below said thin sheet material to permit the heating and stretching thereof, whereby the thin sheet material is reduced in thickness when said drums are rotated.

3. A radio frequency heating device for reducing the thickness of thin iron transformer laminations to maintain the permeability of the laminations greater in the direction of the working and stretching than in the other direction, comprising a pair of drums, said drums being operated together at different peripheral speeds and maintained at a substantially constant torque, a source of radio frequency heating, a radio frequency heating device located adjacent said drums to permit the heating and stretching of said iron transformer laminations and to raise the temperature beyond the annealing temperature whereby said laminations are reduced in thickness.

4. A device for working and stretching sheet material, comprising a pair of drums, means to rotate said drums at a substantially constant torque, a source of radio frequency which is operated above 20,000 cycles per second, a coupling device through which the sheet material is passed to raise its temperature beyond the annealing temperature, said coupling device being connected to said source of radio frequency, means to rotate and couple said drums together to produce a ratio of peripheral speeds having a value greater than one, to force the heated sheet material to stretch, whereby the material running over the drums must stretch in a fixed ratio when the drums rotate.

5. A device for reducing the thickness of thin sheet material comprising a plurality of rotatable drums for rotating and stretching the thin sheet material, said drums having different diameters, a source of radio frequency power, a radio frequency heating device connected to said radio frequency source and having electrodes disposed

above and below the plane in which the thin sheet material is adapted to pass, and means for automatic self adjustment of the speed of said drums to hold the softening temperature of the thin sheet material in the general location of said electrodes.

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