This invention relates to apparatus and a process for rolling wire into extremely thin strips or ribbons having a uniform width to thickness ratio and suitable for use in electrical measuring instruments. As is well known in the electrical measuring instrument art, there are various processes employed in the production of thin metal strips, among which are rolling of foil, electroplating films, and evaporating films. Each of these known processes, however, is found deficient in producing an extremely thin metal strip such as is used in bolometers. For example, when rolling of foil is attempted, difficulty is encountered in the tendency of the foil to stick to the rolls and the scoring of the rolls by the work hardened metal. Trimming the elements to size subsequent to rolling also proves awkward. In the electroplating film process, surface tension difficulties are encountered and, in addition, in order to produce a uniform thickness, it is necessary to plate a large sheet and cut out strips of proper size. This is also an awkward step. Evaporating metal films would at first glance appear to be an ideal method for the preparation of thin strips, but it is found that evaporated metal films have poor temperature coefficients and show a tendency toward excessive electrical noise. Further, strips prepared by this process exhibit large variations from batch to batch with respect to these properties and are therefore unsuitable for electrical measuring instruments.

It is therefore an object of this invention to provide a novel process for producing thin metal strips. A second object of this invention is to provide a novel process for producing thin metal strips by rolling a wire. Another object of this invention is to provide a novel apparatus for producing thin metal strips. A further object of this invention is to provide a novel apparatus for rolling wire into thin strips. A further object of this invention is to provide a novel apparatus for rolling wire into thin strips the thickness of which may be accurately controlled.

These and other objects are accomplished by the apparatus and process hereinafter set forth whereby a flat strip is produced by the mechanical flattening of a round wire whose original cross section is such as to yield the proper dimensions upon being reduced to the desired form. Since such a procedure calls for a tremendous deformation of an extremely fine wire, a wire in a Wollaston type coating is required to provide strength during the deformation process and to permit the necessary handling. It is possible to flatten sufficiently by mechanical means a Wollaston wire consisting of a fine platinum core surrounded by a heavier silver sheath, which could be removed in a nitric acid bath after reduction to ribbon form. The resulting platinum ribbon retains the resistivity and temperature coefficient of the bulk metal, and furthermore is homogeneous and of sufficient strength to withstand slight longitudinal tension.

The process and apparatus for rolling the Wollaston wire into a flat ribbon consist essentially of rolling the wire between a reciprocating cylindrical roller and a flat stationary platen, care being exercised that the wire is supported above the platen between passes of the roller. In this manner elongation of the wire occurs without kinking or frilling.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a front view of the complete rolling apparatus; Fig. 2 is an enlarged front view of a section of the rolling apparatus showing the wire in place; and Fig. 3 is a cross-section of a Wollaston wire before rolling.

Referring to the drawings, there is disclosed in Figs. 1 and 2 the rolling apparatus whereby a uniform thin strip, satisfactory for use in bolometers, for example, is produced. The rolling machine is mounted on a heavy piece of channel iron 1 of sufficient length to hold the motor 2, the crank arm 3 and connecting rod 4, and the main rolling structure to be hereinafter described. The length of the connecting rod was made as short as possible taking into consideration the length of stroke desired and the inadvisability of having the connecting rod make large angles with the direction of the rolling members. In one model constructed the total length of the base plate was approximately three and one half feet.

The driving motor speed was reduced by means of reduction gear 5 to a speed such that the length of the stroke of the roller was six inches at a speed of 100 revolutions per minute. With this speed and length of stroke, a length of wire of suitable dimensions can be rolled within the time of a half hour. It has also been found that a low rolling speed will produce superior results.

The main rider 7 on which is mounted the cylindrical roller 10 is supported for reciprocating movement on guide rail 9 by means of roller wheels 11 one of which is shown in Fig. 2 riding on the top of the guide rail. Two similar rollers, not shown, ride on the bottom of guide rail 9. The roller 10 may be adjusted by means of slot 12 cut into the rider 7 and the screw 13 adapted to narrow or widen the slot so that there is very little play between the main rider 7 and the guide rail 9. Sideways motion of the rider 7 is restrained by three small ball bearings 14 pressing against the side of the guide rail. A fourth ball bearing, not shown, on the opposite side of the rail is spring loaded to provide, in a well-known manner, adjustment for irregularities in the guide rail.

To avoid variation in the angle at which driving forces from the motor 2 are applied to the main rider 7, an auxiliary rider 6 is also mounted on the guide rail 9. The auxiliary rider is mounted by two small ball bearings 15 riding on the top of the rail and a similar bearing on the bottom of the rail. The auxiliary rider 6 is linked to the main rider 7 by means of a short universal joint consisting of a rod 8 which is shaped into a ball at both ends. Each ball is held between two hollow cone set screws 16 which can be adjusted for optimum tightness on the ball-shaped ends. The driving motor 2 is connected to the auxiliary rider 6 through the reduction gear 5, the crank arm 3 and the connecting rod 4 to provide a reciprocating motion to the auxiliary rider 6 and in turn to the main rider 7 through the universal joint members 8 and 16.

Depending from the main rider 7 is a support member 21 upon which is pivotally mounted the yoke assembly 17. On one end of the yoke assembly is mounted the roller 10 which cooperates with the platen 18 to roll the Wollaston wire. Such a wire is disclosed in Fig. 3 and is by definition a fine platinum wire 26 drawn inside a silver sheath 27, which is subsequently removed in
The yoke 17 is provided with set screws 22 and clamp means 23 whereby the roller may be locked in position once it has been set parallel to the platen. The yoke 17 is biased about its pivot by means of spring 19 which coacts with the end of the yoke opposite to the roller 10. The force exerted by the spring 19 on the roller is adjustable and is controlled by means of screw 24 mounted on the yoke 17. Positioned adjacent each end of the platen are ball bearing V pulleys 25 on which the Wollaston wire is placed. The free ends of the wire are weighted, as by attaching small clips 28, so that the wire is supported above the platen about one sixteenth of an inch. The weights on the ends of the wire insure that the wire is under sufficient tension to pull free of the platen between successive passes of the roller, thus permitting elongation to occur without kinking and frillng.

In making a production rolling, a length of wire 20 is placed on the platen of the rolling machine and hung over the two ball bearing V pulleys 25. The free ends of the wire are weighted by attaching small clips so that the length of the wire between the pulleys is supported slightly above the platen 18. For the initial passes of the roller 10, the spring 19 is adjusted to its position of least force and the rolling is carried out until considerable flattening of the wire is obtained. This is done to lessen the possibility of scoring the platen or roller when the contact area is very small. The tension of the spring 19 is then increased to its maximum and the rolling is allowed to continue until a strip of the desired width is obtained.

The surface roughness of the roller and platen plays an important part in the production of satisfactory strips. If both are very smooth, the force necessary to roll the wire out appreciably is great and the time necessary to do this is long. On the other hand, if the surfaces are made too rough, the wire is cut before any appreciable flattening takes place. There is an optimum surface roughness, however, that allows one to roll Wollaston wire as thin as desired without breaking the wire and within a reasonable time. This optimum surface roughness has been found to be about 15 microinches for Wollaston wire with a platinum core 26 and a silver sheath 27.

During the course of rolling, the wire continually changes its position lengthwise with respect to the platen. The peaks of the surface roughness pattern thus move from region to region on the roller as the rolling process goes on. In this way large unit pressures are brought to bear at discrete areas during one pass of the roller, but as the rolling proceeds the entire strip is uniformly subjected to these pressures.

With the rolling mill operating as above, it is consistently possible to roll six inch lengths of Wollaston wires with platinum core diameters of 0.0002" and 0.0004" and silver sheath diameters of approximately 0.0004" until the resulting platinum thickness is of the order of 500 A. The proper choice of Wollaston core diameter is determined by the required width and thickness of the rolled and etched strip. The rolling process not only forces the cylindrical core into a ribbon shape, but the core is also forced out lengthwise so that the original six inch length is usually extended to about seven and one half inches.

After the rolling operation the silver sheath is removed from the platinum in a concentrated solution of nitric acid. The rolled section of Wollaston wire is first placed lengthwise in a glass rod previously waxed. The rod is placed in a container filled with nitric acid and left there fifteen minutes so that all traces of silver are removed from the platinum ribbon. As the rod is slowly drawn from the nitric acid solution, surface tension causes the platinum ribbon to flatten against the wax. The rod is then transferred to a container filled with water and the acid is rinsed from the strip. To dry the strip a third transfer is made in which the rod is removed from the water and placed in acetone. Once the rod has been removed from the acetone bath it is allowed to dry and is then ready for use.

The use of wax on the rod is necessary because platinum ribbons stick so tenaciously to glass it is impossible to remove them without special equipment. Obviously many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically claimed.

1. An apparatus for rolling wire into thin strips of uniform dimensions comprising a platen, means positioned adjacent end and extending above the surface of said platen for supporting said wire, weights attached to the ends of the wire to tension said wire, roller means coating with said platen to flatten said wire, and means for reciprocating said roller in a predetermined manner, the weights causing the wire to pull free of said platen between successive reciprocations of said roller.

2. Apparatus as in claim 1 wherein the surface roughness of the platen and roller is 15 microinches.

3. An apparatus for rolling wire into a thin strip comprising a stationary flat platen, a cylindrical roller mounted adjacent said platen, pulley means adjacent each end of and projecting above the surface of said platen adapted to position said wire between said platen and roller normally out of contact with said platen, a roller assembly mounted said roller, means for adjusting said yoke assembly whereby the force exerted by said roller on said wire may be controlled, a first rider means supporting said yoke assembly and imparting reciprocating movement thereto, motor means for driving said rider, and an auxiliary rider positioned between said first rider and said motor means and connected to said former by means of a universal joint whereby variation in the angle at which driving forces from the motor are applied to the first rider are avoided.

4. Apparatus as in claim 3 wherein the surface roughness of the platen and roller is 15 microinches.

5. A process for rolling wire into a thin strip which comprises, positioning a wire of predetermined diameter on pulleys between a fixed platen and a movable roller, weighting the ends of the wire so that the portion of wire between the pulleys is normally positioned above the platen, and reciprocating said movable roller to displace said wire into contact with said fixed platen and thereby roll said wire into a thin strip.

6. A method for producing metallic strips having a thickness in the order of 500 A. comprising the steps of supporting a wire encased in a deformable molten wax sheath above a flat, smooth surface, maintaining said wire under tension so as to keep it taut and repeatedly passing a roller back and forth along the length of said wire while subjecting said roller to a force directed at approximately right angles to the length of said wire whereby said wire is firmly held in contact with said smooth surface by said roller only during each pass of said roller.

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