Supersedes former 14-3-4

The process of rolling wire into ribbon is herein described.

1. DETERMINING WIRE SIZE FOR A RIBBON

After a ribbon thickness and weight has been determined, the required wire weight in most cases may be determined from recorded data on ribbon previously rolled. Ribbon of approximately the same width will have approximately the same ratio of wire weights to ribbon weights. If a ribbon width is required which has not been rolled in the past, then from a known, nearest width to it, a wire weight is approximated. This wire is then rolled to the required width and from the resultant ribbon weight a more nearly correct wire weight is determined.

Wire rolled into ribbon is elongated and loses weight per unit length. Elongation is caused by the metal being pushed back of the rolls. Loss of weight is greatest in the first pass thru a mill. It is also greater in mills with small diameter rolls than those with large diameter, the more nearly the roll surface approaches a flat surface the less the elongation and loss in weight and the greater the width.

In setting round wire weight ranges it has been found advisable to make them slightly closer than the ribbon weight range because of variation in the working qualities of different lots of wire. These variations seldom occur with pure nickel wire but are often found in the nickel alloys. The ratio of wire weight to ribbon weight is approximately the same for different sizes of wire rolled on machines with the same size rolls.

2. NUMBER OF PASSES REQUIRED TO ROLL A RIBBON

The number of passes required to roll a ribbon is determined by the dimensions of the ribbon and the hardness of the material to be rolled. Usually a fairly close approximation can be made by considering past experience and the required passes and procedure for a similar size and type of wire. Also the tolerances of the dimensions of the finished ribbon are taken into consideration.

3. ROLLING EQUIPMENT

There are in use, at present, four types or styles of rolling mills for the flattening of round wire. Ribbons rolled on these machines are given in material handling notices. For round wire sizes from which filament ribbon is rolled refer to 14C-3-1. From these notices, the method of rolling a proposed type of ribbon can be approximated.

a. Six Inch Mills Manufactured by the Standard Machine Co. - These are strong mills, suitable for any work which does not require maximum accuracy and they are well suited for heavy work, being equipped with roller bearings and fitted with gear driven top and bottom rolls. High pressures may be applied to the rolls without causing undue trouble with the bearings. Probably the best accuracy which can be obtained with these mills is ±1 mil in nickel ribbon about .030" wide rolled from 10 mil wire, or .030" ribbon rolled to approx. .040".

3. ROLLING EQUIPMENT (Cont'd)

b. Six Inch Mills Manufactured by the Torrington Mfg. Co. These mills are equipped with half-babbit-lined bearings. The bottom roll is gear driven; the top roll runs free and is driven by the friction against the wire passing under it. With properly maintained rolls, these bearings should hold a tolerance on 15-16 mil ribbon rolled from approx. 8.3 mil wire, of about ±.0003" or .0004".

Due to the friction in this type of bearing it is impractical to apply as much pressure to these rolls as can be applied to those of mills of the roller bearing type. There is a tendency for the top or idling roll to drag which causes excessive wear at the point of contact with the wire. Bearings and rolls will heat causing variation in ribbon width.

c. A Six Inch Mill Made by the Waterbury-Farrel Co. This mill is equipped with roller bearings smaller in size than those of the Standard mill and is used primarily for starting molybdenum ribbon and filament ribbon. It will roll wire to the same tolerances approx. as the Standard mill. It is not as heavy as the Standard mill and cannot handle as high a total force.

d. A one and one-half inch mill has plain bearings of brass blocks having clearance holes into which the rolls are fitted and revolve. The bearings are approximately the same length as the rolls and prevent the rolls from being sprung or bent. Both rolls are driven being connected by herringbone gears. The bottom roll is partly immersed in an oil bath which provides a simple means of lubrication as well as a means for maintaining a uniform temperature on the rolls.

The 1 1/2" mill is well suited to the rolling of fine wire where width tolerance is low. It should roll 6 mil nickel wire to a width of .0128" within a width variation of not more than ±.0002" and should be used for smaller diameters of nickel and nickel alloy wires.

4. OILING ROLLS

A lubricant is used on the surface of the rolls except when they are used for rolling a ribbon that does not require very much flattening and therefore not much pressure as in the case of rolling 7.9 or 8.6 mil wire to a ribbon having a width of approximately .016". If oil is used with the Torrington mill, the upper roll has a tendency to slip and not turn since it is driven by the lower roll by friction with the wire. In rolling #16 metal the use of oil has the effect of decreasing the number of passes required for rolling a ribbon as well as to reduce wear on the rolls. When rolling nickel, the use of oil has only the effect of reducing roller wear. This difference is probably due to the fact that nickel ribbon has not been rolled as thin as #16 metal ribbon.

Any suitable machine oil that does not leave an insoluble residue on rolls should be used on the surface of the rolls of the one and one-half inch mill. The rolls and bearings of this mill are oiled by the lower roller bearing and most of the roll being immersed in oil and the lower roll carrying oil to the upper roll and its bearing. Any good grade of lubricating oil may be used on the surface of the rolls of the other mills. At present Ansler oil is used and is standard for filament ribbon.

4. OILING ROLLS (Cont'd)

If available, the use of a water-borne lubricant is recommended. This lubricant is supplied to the rolls by running the lubricant onto the top roll in such a quantity as to flood the rolls and provide a cooling effect as well as lubrication.

At present the water-borne lubricant used is about a 1 1/2 pt. to 4 gal. $H_2O$ of Standard Oil Extreme Pressure Drawing Compound 33-D-26. This is circulated from a five-gallon can by means of a 1/8" centrifugal pump. The lubricant is cooled by evaporation and cold water must be added from time to time to make up for that lost by evaporation. Of course any other circulation system would be satisfactory. A good tank and pump unit such as that made by the Ruthman Machinery Co. of Cincinnati, Ohio, is suitable.

Up to the present only the Standard mills have been provided with water-borne lubricant. Tests seem to indicare that on nickel and nipron the round wire sizes will be considerably different than when this oil is used as lubricant. Also provisions for prevention of nipron rusting after drawing must be made, if a water-borne lubricant is used.

5. CHECKING ROLL ALIGNMENT AND ROUNDNESS

Take a piece of round nickel wire of 8 or 10 mil size and divide it into two parts on two spools. Guide each piece thru the rolls as close to the edges as possible. If the rolling surfaces are parallel the widths of the two wires will be the same.

To check the accuracy of rolls and bearings take a length of ribbon equal to the circumference of the roll and measure the width of ribbon at points 1/2 to 1 inch apart. These width readings should not vary more than the variation limits given in the description of the rolling mill.

6. ROLL WEAR

The mill rolls will wear at the point of contact with the wire, forming grooves. Along each side of these grooves are ridges which seem to be formed by the "flow" of the displaced metal from the groove. This is particularly noticeable where very hard wire has been rolled or where an attempt has been made to obtain too great a width in one pass. In this case the new spot for rolling must be located far enough away from the old one to avoid these ridges.

7. WIRE GUIDES AND WINDING RIBBON

Each mill should be provided with an unspooling head having a smoothly applied tension device. Tension, applied at this point will reduce the ribbon weight and is very convenient if the round wire is too heavy. It is, however, not recommended in general practice that tension be used for this purpose as it adds one more variable which may be readily dispensed with provided the round wire weight range used is carefully maintained.

If the wire is dirty after leaving the unspooling head, it should pass between two wool felt pads held in a suitable clamping device. These will remove most of the dirt from the wire and are used merely to protect the rolls.

7. WIRE GUIDES AND WINDING RIBBON (Cont'd)

From the felt pads the wire should pass thru a guide which consists of two pieces of flat steel (preferably hardened) which are held together by screws. A slot runs along the length of the guide. This should be large enough to provide a running fit for the wire to be rolled. The guide should be tapered at the end toward the rolls so that it can be brought in between the rolls as close to their point of contact as possible.

The ribbon, upon leaving the rolls, is brought into contact with a "V" grooved flat bottom pulley made of hardened steel. This pulley is adjustable vertically and laterally. The flat bottom of the pulley is several thousandths wider than the width of the wire.

From this pulley the wire passes over another similar pulley to which is attached a mercuroid switch for stopping rolls when ribbon breaks, and then under another pulley to the spooling head from which it is wound onto the spool. The spooling head mechanism moves the spool laterally back and forth in back of its guide pulley with as small a pitch as possible without having the edge of one turn of ribbon overlap the edge of the one before it. If the pitch is too great there is danger of wire falling in between the turns of the previous layer. This tends to catch when the wire is being unspooled. A slipping mechanism is provided for holding the spool and will allow the shaft of the spooling head to revolve faster than the spool. This applies a light tension to the ribbon.

8. CAUSES OF RIBBON CURVATURE

1. "Curl" or curvature apparent when a short length of ribbon lies on its edge on a plane surface, may be caused by the following:

a. Ribbon leaving the rolling surfaces in a line which forms an angle of other than 90° with the line thru the axis of the two rolls.

b. Ribbon dragging over any stationary surface such as a tight pulley or sharp edge.

c. Ribbon passing over flat bottom "V" pulleys having flats which are worn or too narrow or which have too small diameters.

d. Too much tension applied thru the spring on the tension - slip mechanism of the spooling head.

e. Too much tension or too small spools at spooling. This tension should be just heavy and smooth enough to keep the ribbon from jumping.

2. "Wave" or curvature apparent when a short length of ribbon lies with its width in contact with a flat surface may be caused by:

8. CAUSES OF RIBBON CURVATURE (Cont'd)

a. Round wire having too much curl which in turn is caused by drawing the wire thru the finishing die with the direction of the wire not following the axis of the bearing of the die. Short irregular waves may be caused by too little draft at this die, by a die with a defective cone or by too much tension on the wire at spooling. The latter can be corrected by wrapping the wire one turn about a driven drum which will apply the necessary "pull" to the wire for drawing and allow the wire to wind onto the spool without tension.

b. The angle formed by the line of ribbon and the line of contact of the two rolls. On each mill the guide pulley is adjustable to provide a means of correcting this.

c. Pulleys which are not in line with each other or which have worn or narrow flat bottoms.

d. Too rapid cross feed motion on the spooling head.

e. Rolls not parallel or with worn surfaces.

3. "Twist" in ribbon may be detected by allowing a length of about six feet of the wire to hang free from the spool. Upon drawing the wire between thumb and forefinger from the spool to the free end, this end will revolve to indicate the amount of twist. Causes are:

a. A regular side curve which when allowed to hang may take the form of a twist because one side of the ribbon is longer than the other.

b. A twist in the ribbon during rolling particularly when this occurs between the rolling surfaces and the guide pulley.

It should be remembered that any of the three defects mentioned above may occur at subsequent operations and from similar causes.

**9. ANNEALING

Occasionally during rolling, the ribbon must be annealed before continuing with the rolling. No annealing can be specified as the need for annealing is dependent on (1) the previous treatment during drawing, (2) type of material and (3) the number of passes required to bring about desired dimensions. In general, annealing requirements will have to be determined by experience. Below are listed sizes at which two materials are annealed under present methods of wire drawing and rolling.

**9. ANNEALING (Cont'd)

| Size | Material | Drawn from | Annealed at |
|---|---|---|---|
| MB4 | Molybdenum | §§58.7-61.1 mg/200mm | .027";.036" and .041 |
| MB9 | Molybdenum | 60.5-61.5 " | .027";.036";.050";.054"& .057" |
| .002"x.125" | Nickel | §.025" | .092"and .115" |
| .001"x.125" | Nickel | .0198" | .095" and .108" |

§ This wire is annealed at this size before rolling.
§§ This wire has a T.S. of 45-52 mg/mm/200mm.