"Seam of Paper Machine Wire"

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Not only the life of the wire but also the quality of the paper depends on the seam of it (wire). While there are various ways of making the cloth endless like weaving, stitching, welding etc., the proper kind of seam is selected on the consideration of two main points—its life and quality with respect to the mark on the Paper.

The author has discussed at length the merits and the disadvantages of different kinds of seaming and causes of seam failure.

Paper Machine Wire is one of the important items, on which depends not only the quality of the paper, but also the entire flow of the paper making process.

If something goes wrong somewhere in the cloth, we find the whole paper making Factory at standstill. A defective cloth not only consumes time, but also labour and money. Time, labour and money are lost both in Paper Mill and Wire Industry. Cloth once rejected, is of no metallurgical use, as it generally contains a mixture of phosphor bronze and brass.

There are various factors that control the life of the wire cloth, like mechanical conditions of the machine, type of pulp, speed of the machine, quality of the wire an the seam.

Seam is a must in every cloth. Not only life, but even the quality of the paper depends on it. A bad seam means a mark on the paper. There are various ways of making the cloth Endless and requisition of seam is made after considering two major points, its life and quality with respect of mark on the paper.

As far as strength is concerned, we put them under following descending order :

(1) Woven

(2) Stitched by Stainless Steel Wire

(3) Welded

(4) Soldered

For the production of the fine paper, we prefer either Soldered or Welded Seam, which being the weakest of all. The strength of the soldered seam is nearly 20% less than the strength of the parent cloth and in case of welded, it is around 16% less.

Soldering :

We are at present following the practice recommended by our Technical Collaborators in Norway.

In simple, each wire of the warp has to be endless by joining both of its ends. In a cloth of 6 Meter width, the numbers of wires in warp are around 15,000 and each has to be endless. The diameter being somewhere between 0.22 to 0.28 mm.

In case, we miss a single wire, the life of the cloth will also reduce, because of the concentration of various stresses at a point, causing fatigue failures.

We first cut the cloth as per the required dimensions, keeping an allowance for stretching. The carefully cut and trimmed cloth is then cleaned to remove the oxide layer and is then coated with a thin film of flux. The flux helps in keeping the material free from any oxide formation even if kept in exposed condition at elevated temperature. The ends of the cloth are then brought near to each other and the gap is filled with a silver soldered wire. The silver soldered wire of 0.23 mm. dia. is having a composition of 80% silver and balance copper and other alloying elements, melting point between 740 to 790°C. The nearby region is first pre-heated and then under controlled oxidising

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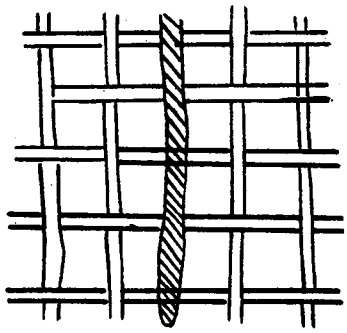
atmosphere, we melt solder-wire. The solder melts and diffuses into the phosphor bronze wire, making each wire endless. The flame we use is by burning hydrogen and oxygen, keeping it always oxidising. (See Fig. 1).



Soldering
Fig 1

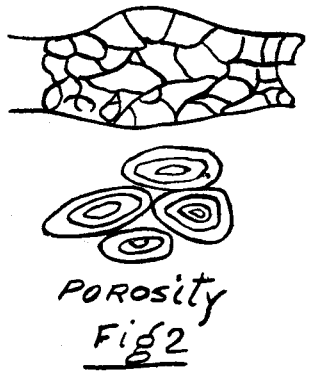
The process involves in short the whole of metallurgy like removal of oxide film, pre-heating, melting casting and finally the phenomena of diffusion.

Generally, for Fourdrinier machines, the material for warp is phosphor bronze alloy of 0.3% P, 6.6 to 7.5% Sn balance Cu and for weft either of same phosphor bronze or 80/20 brass.

If we see a microphotograph, we will find that the core of the solder wire is of silver-rich copper alloy in as cast condition, showing fully developed crystals i.e., solid solution of Cu in Silver in the matrix of and eutectic.

As we move towards the wire, we find more and more of copper along with tin. As the wire is of copper tin alloy, the transformation of silver rich as cast structure to somewhat annealed copper rich structure give rise to various new phases having different physical and chemical properties.

Both Copper Silver and Copper Tin Alloys, being long freezing in nature, give dendritic structure and a further possibility of dendritic porosity. So extreme care is taken at the time of solidification to feed the metal, once there is a formation of micro porosity due to poor feeding, the only treatment being annealing, which is impossible for such



Porosity
Fig 2

delicate wire in woven condition, which lies along with a brass wire of 80/20 composition. Any variation in the oxidising flame will cause absorption of hydrogen by the molten silver copper alloy, giving further trouble due to porosity.

The soldered portion is not only different from the parent wire chemically, but also there is a change in the mechanical properties. Due to preheating, the small portion on either side of the seam get annealed and then there is some grain growth which results in the increase in Elongation and decrease in Tensile value. In spite of this the soldered seam has got its own advantages. As the soldering temperature being not very high, the joining is mostly by diffusion and so the tendency of Bronze wire having very large grain structure is not there and so there is not much change in physical properties. The operation being at low temperature does not allow the loss of Zinc, Tin or Phos of Brass and Bronze wire. In soldering, the silver wire helps in keeping the mesh count of the seam to perfect, not allowing extra drainage of the pulp solution.

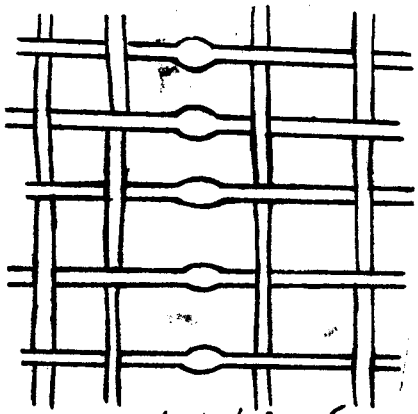
Welding :

Under certain conditions, welded seam, seems to give better life than soldered one, mostly because here we actually melt the individual wire and join them, but in soldering, we take the help of a foreign metal.

In this process, we bring both ends of the cloth in contact with each other, and after preheating the nearby area, we melt the edge of each individual wire and mix the molten alloy together to form an endless cloth. The flame being oxidising

by burning oxygen and acetylene gas. As the operation being conducted at high temperature and also we are handling the Bronze in Molten stage, care is taken in keeping the flame as far as possible, oxidising. Any excess of acetylene will give unsoundness in the weld due to presence of hydrocarbons.

There is also a slight loss of Phos and Tin at the weld. The chance of Zinc contamination is always there. Zinc comes from the wire, lying next in the weft. Thus a welded Seam also affects to certain extent, the brass wires of the weft. In welding, we get small globules at the seam, which forms an elevated surface. This comes in constant contact at high speed with various rolls, causing work hardening at the seam. The weld also leaves the weft wire at a distance, creating an extra gap. This also gives slight trouble at the suction boxes. (See Fig. 3). In whole, a welded seam has its own advantages and disadvantages over the solder seam.

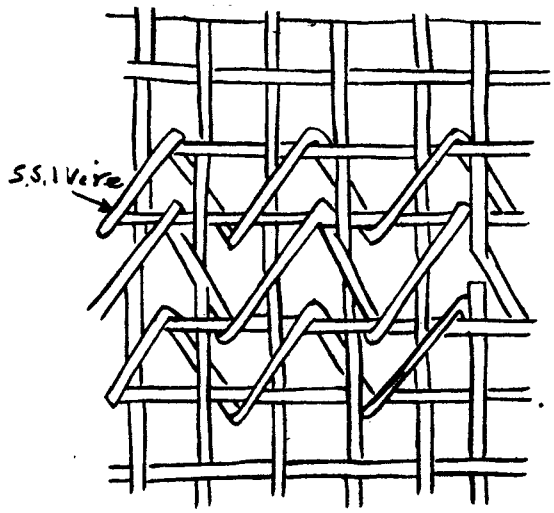


Welding
Fig 3.

Stitching :

In general, we join the first weft wire of either end by stitching it with a suitable Stainless Steel Wire. The position of weft wire is reinforced by stitching it with various other weft wires of the cloth. The Stitching Process of Seam is different for different weaves, simple being for Plain Weave.

As shown in Fig. No. 4 first of all, we melt the tips of each warp wire to give a rounded shape, so as to avoid the sharp cut. The first two consecutive weft are stitched together to give an



Stitching of Plain Wave by Stainless Steel Wire.
Fig 4

extra strength to the weft wire facing the end. The Stainless Steel Wire, which we use for this purpose is of 0.22 mm ϕ. The next operation being stitching of the first weft wires of opposite end of the cloth again with a 0.22 mm ϕ. Stainless Steel Wire.

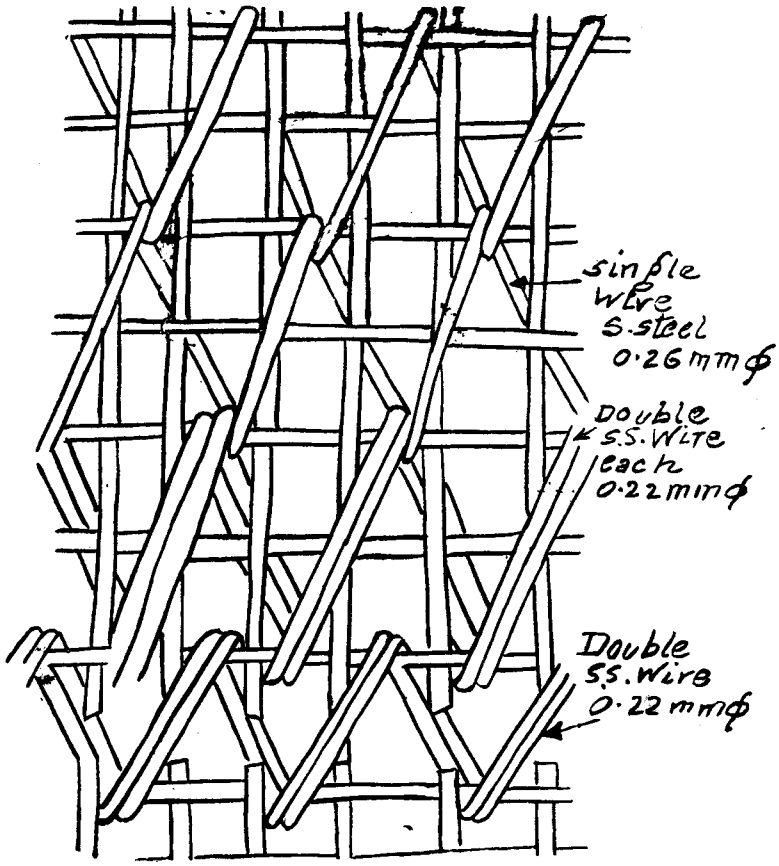
For Single Twist, as shown in the **Fig. No. 5,** we follow the procedure mentioned below :—

First Stitch : Stitching of 1st and alternative weft, with the help of 'Double' 0.2 mm ϕ Stainless Steel Wires.

Second Stitch : Stitching of 3rd and 5th weft wire with the help of a 'Single' 0.26 mm ϕ Stainless Steel Wire.

Third Stitch: Stitching of 5th and 7th weft, with the help of a 'Single' 0.26 mm ϕ Stainless Steel Wire.

Final Stitch : The first weft wires of the either ends of the cloth are stitched with the help of a 'Double' 0.22 mm ϕ Stainless Steel Wire.



stitching on Single Twist by Stainless Steel Wire

Fig 5

The first, second and the third stitches give a holding strength to the wire, against the stretching tension of the cloth.

The Stitched seam is better than the welded or soldered as far as the strength is concerned, but then the opening area of the wire, in the nearby region of the seam is not very uniform. The opening at seam is chocked with stainless steel wires passing between the two ends of the cloth. Also there is a considerable rise in the surface at the seam, making it difficult to give a fine finish to the paper.

Woven :

As you might have seen the procedure is similar to the ordinary weaving of a cloth, with a difference that it is on a small scale and is done manually. This type of seam is best in strength, but opening at seam area is very much crowded. These seams are mostly used in Double and Single Twist Weaves.

Discussions on the Seam and its failure :

As we move towards the welded or soldered portion of the seam, there is a change from partly annealed to either fully annealed or as cast structure of the grains. At the point of this transformation there is a possibility of development of 'hair line cracks' due to contraction while heating and cooling of wire. These fine cracks then undergo various tension and contraction cycles, over the guide rolls, causing fatigue failure. That is the reason for the failure of wire not at the seam but somewhere near to the seam.

Though seam being some 16% to 20% and weaker than the parent cloth, it is not always true that the life of the cloth depends entirely on the seam. The seam inspite of all this is sufficiently strong enough to withstand the maximum physical test, which the machine can offer. During the process there may develop and other sport, which is not strong enough to withstand the minimum properties required, and that can be the cause of failure.

Also we find the opening at the soldered seam are not uniform. This is because the warp wires are at different levels and they join the molten solder metal at different angle. This causes the variation of the opening. This is better explained by the help of the Fig. No. 6.

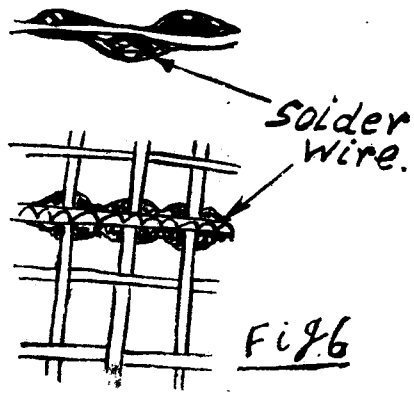


Fig 6