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Bevel Gears for STELCO No-Twist Mill; Visit to Indiana Gear Mill

M. J. Knott

R. D. Wykes

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TO: As Noted

FROM: M. Knott and R. D. Wykes

SUBJECT: Bevel Gears for STELCO No-Twist Mill
Visit to Indiana Gear By
W. Morgan, M. Knott and R. D. Wykes

Delivery

The present delivery date is July. However, if the nitriding process does not result in excessive distortion, Indiana are hopeful of making delivery in June. This will be known by May 14th, when the first pair have been nitrided and inspected.

The Indiana plant shuts down from June 26th to July 12th.

Also discussed, but not settled was whether partial shipment should be made and where spares should be shipped to. R. Wykes will be able to evaluate the need for partial shipment when he arrives in Britain and will advise Indiana accordingly.

Confirmation of Order

Indiana were asked if they had sent a confirmation of order to Davy & United. They told us that Davy & United have not yet submitted an order for the revised price. When they do, Indiana will confirm the order. Ed Randall is looking into this.

Machining

Gears are now in various stages of manufacture. Mr. Kornmann said that the hardness (RC 32-36) of the gears is making the cutting operation difficult. Cutting speed is slow and the cutters require sharpening after two gears have been cut. He asked if the material could be a little softer in future, seeing that the gears are subsequently nitrided.

Runout

Indiana have agreed to establish the high point of runout on all gears and mark it with an "X". Bearing inner races also have high points marked and by opposing the runout on gears and

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Bearings we can minimize its effect. Gear drawings should have an appropriate note added when the next revision is made. Assembly drawings should also carry necessary assembly instructions.

Balancing

There is some doubt as to whether the Indiana balancing machine can handle the heavy STELCO gears. If it can, they will be able to balance to the required limits at the stipulated speed (700-1000 rpm). If the gears prove to be too heavy for their machine, a local Indianapolis company can handle them, but at a maximum speed of 400 rpm. Indiana will call us if this is necessary.

Test Running & Assembly

The gears will be tested in a Gleason 14 Machine. The mounting distance given on the drawing for any gear represents the nominal position for that gear under normal running conditions. This mounting distance may be modified slightly by Indiana to ensure that the gear operates in the position which gives the best tooth contact pattern.

Gears will then be shifted in the test machine to a minimum mounting position. (The minus tolerance on the drawing.) The contact pattern must still be satisfactory. Backlash in this minimum position will be in the range indicated on the drawing.

Gears will also be moved out to a maximum mounting position in the test machine. (The plus tolerance on the drawing.) Contact pattern must be satisfactory. This maximum position is also the assembly position for the gears. Indiana will establish the exact mounting distance for all gears when in the maximum position and etch it on each member. At the same time they will establish the backlash and etch it on the gear.

Our drawings presently are not specific about which mounting distance and backlash is to be etched on the gears. This should be rectified for future contracts.
The gears will also be run with a .016" offset. Mr. Kornmann will call Mr. Fallon of Gleason following the testing of the first pair and they will decide whether this figure is satisfactory. We will be informed of their decision.

Indiana will provide two contact patterns for each pair. One will be the pattern to be obtained at assembly when the gears are at their maximum mounting distance. The other will represent the pattern to be obtained in the nominal position given on the drawings. This is the expected running position when thermal equilibrium has been reached.

Manufacturing and Design Changes

Indiana have not yet found it necessary to deviate from the manufacturing procedure spelled out on the drawings.

They do feel that manufacturing and testing would be more trouble-free and economical if the driven bevel were designed as a ring gear rather than being integral with the shaft. Concern was voiced over possible distortion caused during nitriding to the larger integral gears of this group. Also the Gleason 14 Machine will not accept the size of shaft we use. Indiana have had to design and build special fixtures to adapt the testing machine to these gears. This would not be necessary if the driven bevel were a ring gear. We should study this, bearing in mind not only the cutting and testing operations, but also possible assembly problems and loss of space behind the driven gear if we go to a bolted flange; this could interfere with present lubrication lines.

Indiana will keep us informed as to whether concern is justified over nitriding distortion.

Future Orders

Mr. Kornmann made the point that setup time is quite high. In the case of the J, and L, and Bethlehem contracts, if we decide to have Indiana make the bevel gears for these jobs, there will be a considerable cost saving if both sets of gears are ordered together.
It is interesting that for each batch of gears ordered, they make one extra. In the case of STELCO, the order consists of two sets of gears required for the mill and a further set for spares. Indiana is making four sets.

**Nital Etch**

Indiana use nital etching as a normal part of inspection of ground parts. The etching procedure differs somewhat from that shown in the Buchler Specification.

The procedure they follow is:

1. Vapor degrease for approximately 1 minute, turning parts over if necessary. Inspect for cleanliness.
2. Electrolytically clean in hot alkaline solution. Indiana use 8 ounces of Anodex No. 2 (made by Mac. Dermid of Waterbury, Connecticut) in one gallon of water at 180°-200° F. Parts are held in this tank for 2 minutes.
3. Rinse in cold water, agitating to ensure cleanliness.
4. Immerse 20 to 30 seconds in a 2% solution of nitric acid, agitated to give a good mix.
5. Rinse in cold running water.
6. Immerse for 3 minutes in a 10% solution of hydrochloric acid in methanol (or alcohol).
7. Rinse in cold running water.
8. Immerse in 5% solution of sodium hydroxide in water.
9. Hot water rinse, air dry and coat with rust inhibiting oil.
10. Inspect for:

   a) Tempered areas caused by grinding burns. These will appear

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as dark spots or patches.

(b) Rehardened areas caused by grinding burns which were tempered and have rehardened due to contact with coolant. These appear as light marks surrounded by a dark tempered area.

The nital etching operation appeared to be used successfully by Indiana for detection of overheating caused by grinding. It requires some skill in determining how bad a particular burn is and also, if it is in a location which requires that a part be scrapped.

M. Knott and R. D. Wykes

NK&RDW/cac