THE SPRING RESEARCH AND MANUFACTURERS' ASSOCIATION

THE DEVELOPMENT AND TESTING OF A SPINNER STRAIGHTENING ATTACHMENT FOR AN AUTOCOILING MACHINE

by

M.R. Southward, B.Sc

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SUMMARY

Previous investigations by the Association have shown that the process of spinner straightening in comparison with roller straightening produces a larger reduction in coiling tolerances. It has also been shown that the process of spinner straightening does not have any detrimental effect upon the wire, and any changes in properties that do occur are restored after a suitable low temperature heat treatment.

The spinner device used in these earlier investigations had not been used before in conjunction with an autocoiling machine in the production of helical compression springs. Consequently many problems were encountered and solved during the matching of the two machines.

This report concerns the designing of a spinner straightening device as an attachment to an autocoiling machine and the subsequent testing of that arrangement. The results indicate that this device and its combination with a coiling machine was satisfactory. Also that the percentage improvement in coiling tolerances brought about by spinner straightening increased with increasing spring index.

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1. INTRODUCTION

An initial investigation by the Association into the straightening of wire prior to the autocoiling of helical compression springs[(1)], concluded that spinner straightening caused a larger improvement in coiling properties than did roller straightening. More recent work[(2)] investigated the effect of spinner straightening upon the wire, from the aspects of wire properties, surface condition and fatigue properties of springs produced. This showed that the only change in the wire caused by spinner straightening was a depression of the proof stresses which were restored after a suitable low temperature heat treatment. Thus it was concluded that spinner straightening had no detrimental effect upon the wire during straightening.

The spinner device used in these earlier investigations caused a marking of the wire due to the type of die and the spinning of the head around stationary wire. In order to remove these problems a device has been designed and built to be compatable with an autocoiling machine. Once built the device was attached to a Wafios UFM8 machine and tested. The design of the spinner die was modified until a satisfactory configuration was achieved that had a low wear factor and produced straight lengths of wire. Coiling trials were then undertaken using one wire size and various spring indices.

2. DESIGN OF SPINNER ATTACHMENT

Two problems arose in the previous investigations with the use of a spinner straightening device in conjunction with an autocoiling machine. The first of these was the dwell time during the 'cut-off' sequence. Although power to the spinner device was interrupted, the spinner head still rotated around stationary wire whilst the motor slowed down and then restarted. Consequently the spinner head for this investigation was designed to be powered by a brake motor, actuated by the drive roll mechanism. This resulted in virtual instantaneous starting and stopping of the spinner head at the beginning and end of the coiling sequence.

The second problem had been the marking of the wire, although not detrimental to the spring performance it was regarded as undesirable. This marking was caused by the Tungsten Carbide dies in the spinner head and the first attempts to alleviate this problem was to employ dies manufactured form nylatron. These dies did not mark the wire but resulted in a small life expectancy. The final solution was to fit nylatron bushes to the outer race of ball bearings and mount these in the dies as shown in Fig. 1. Using this method the wear was reduced to a very low level. The complete device was then attached to the coiling machine (Fig.2) and tested.

3. SPRING DESIGN

The material selected for this investigation was a patented cold drawn spring steeel wire to BS 5216 ND3. A total of four spring designs were selected and listed in Table I. The first three designs were employed for the coiling trials and the fourth design used for fatigue testing.

4. EXPERIMENTAL PROCEDURE

The coiling tool arrangement was removed from the machine to enable the drive rolls to pull the wire through the spinner head and produce sample lengths of wire. The dies were then adjusted to cause most distortion of the wire entering the spinner head and then reducing to minimal distortion at the exit from the head. The degree of distortion of the wire was altered until the wire samples were produced as straight as possible.

The coiling tool arrangement was repositioned and adjusted to produce springs to the required design. The coiling machine and straightener were then switched on and after producing 200 springs the last 10 of every 100 were collected until 1200 springs had been produced. The spinner device was then removed and the coiling procedure repeated to produce springs from unstraightened wire for comparison.

The complete coiling trial for the unstraightened and spinner straightened wire was then repeated for two further spring designs. The free length of the collected springs was measured on a Nikon profile projector as shown in Fig.2.

Finally, sample springs were coiled to spring design number 4 from both as received and spinner straightened wire for fatigue testing. The springs were cycled between two stress levels until failure occurred.

5. RESULTS

The free length measurements of the collected springs were analysed and are listed as 'short term' tolerances in Table II and 'long term' tolerances in Table III. It should be noted that a tolerance band of 3σ (where σ = standard deviation of free length) encompasses 99.7% of the free length variation.

To enable a comparison to be made between the measured variation in free length with that required to meet the industrial specification, the free length tolerance as specified in BS 1726 was calculated. This value is shown in both Table II and III for each spring design. Table IV contains the comparative fatigue results for the two wire conditions.

6. DISCUSSION

In order to detect the wear performance of the spinner die material, single lengths of straightened wire were collected before and after each coiling trial and visually compared for degree of straightness. Since no difference in straightness was detected and no adjustments were necessary to the dies between each trial, the final spinner die configuration was regarded as satisfactory.

The coiling properties of as received and spinner straightened wire can best be compared by considering the 'short term' tolerance (Table II). These results are regarded as the potential coiling properties for this particular machine arrangement and spring design. For each spring design, spinner straightening improved the coiling tolerances of the as received wire and can be expressed as a percentage improvement.

Spring Design No.	1	2	3
% Improvement	12.2	17.6	31.9

Comparing these results with the actual spring designs indicate that, percentage improvement in coiling tolerance due to spinner straightening increases with increasing spring index.

Actual coiling properties are depicted by 'long term' coiling tolerances in Table III. These results indicate that spinner straightening improves coiling tolerances for all but one spring design number 2 where no improvement occurred. Fatigue results indicate no significant difference in fatigue life for the as received and spinner straightened wire.

7. CONCLUSIONS

1. This design of spinner device and dies has eliminated the previous problems of attaching such a device to an autocoiling machine.

2. Spinner straightening improves the coiling properties of cold drawn wire and has no significant effect upon fatigue life.

3. The percentage improvement in coiling tolerances increases with spring index for the range of indices considered.

8. REFERENCES

1. SOUTHWARD M.R. "The Effect of Roller and Spinner Straightening on the Free Length Variablity of Springs made on an Autocoiling Machine".
THE SPRING RESEARCH AND MANUFACTURERS' ASSOCIATION
Report No. 269.

2. SOUTHWARD M.R. "An Investigation into the Effect of Spinner Straightening Wire".
THE SPRING RESEARCH AND MANUFACTUERS' ASSOCIATION
Report No. 310

TABLE I SPRING DESIGNS

	SPRING DESIGN No.			
	1	2	3	4
Wire Diameter (mm)	0.71	0.71	0.71	0.71
Mean Coil Diameter (mm)	4.00	6.17	8.56	5.87
Spring Index	5.6	8.7	12.1	8.3
Active Coils	6.5	6.5	8.5	6
Total Coils	8.5	8.5	10.5	8
Free Length (mm)	12.37	15.2	18.72	17.96

TABLE II 'SHORT TERM' FREE LENGTH COILING TOLERANCES

SPRING DESIGN NUMBER	BS 1726 TOLERANCE mm	AS RECEIVED WIRE		SPINNER STRAIGHTENED WIRE	
		σ	3σ	σ	3σ
1	0.34	0.049	0.147	0.043	0.129
2	0.43	0.108	0.324	0.089	0.267
3	0.54	0.323	0.969	0.220	0.66

TABLE III 'LONG TERM' FREE LENGTH TOLERANCES

SPRING DESIGN NUMBER	BS 1726 TOLERANCE mm	AS RECEIVED WIRE		SPINNER STRAIGHTENED WIRE	
		σ	3σ	σ	3σ
1	0.34	0.077	0.231	0.055	0.165
2	0.43	0.113	0.339	0.116	0.348
3	0.54	0.336	1.008	0.230	0.690

TABLE IV FATIGUE RESULTS

	AS RECEIVED SPRINGS	SPINNER STRAIGHTENED SPRINGS
INITIAL STRESS N/mm2	75 N/mm2	75 N/mm^2
MAXIMUM STRESS N/mm^2	1015 N/mm^2	1015 N/mm^2
No. of SPRINGS TESTED	18	19
MEAN LIFE CYCLES	339,000	371,000

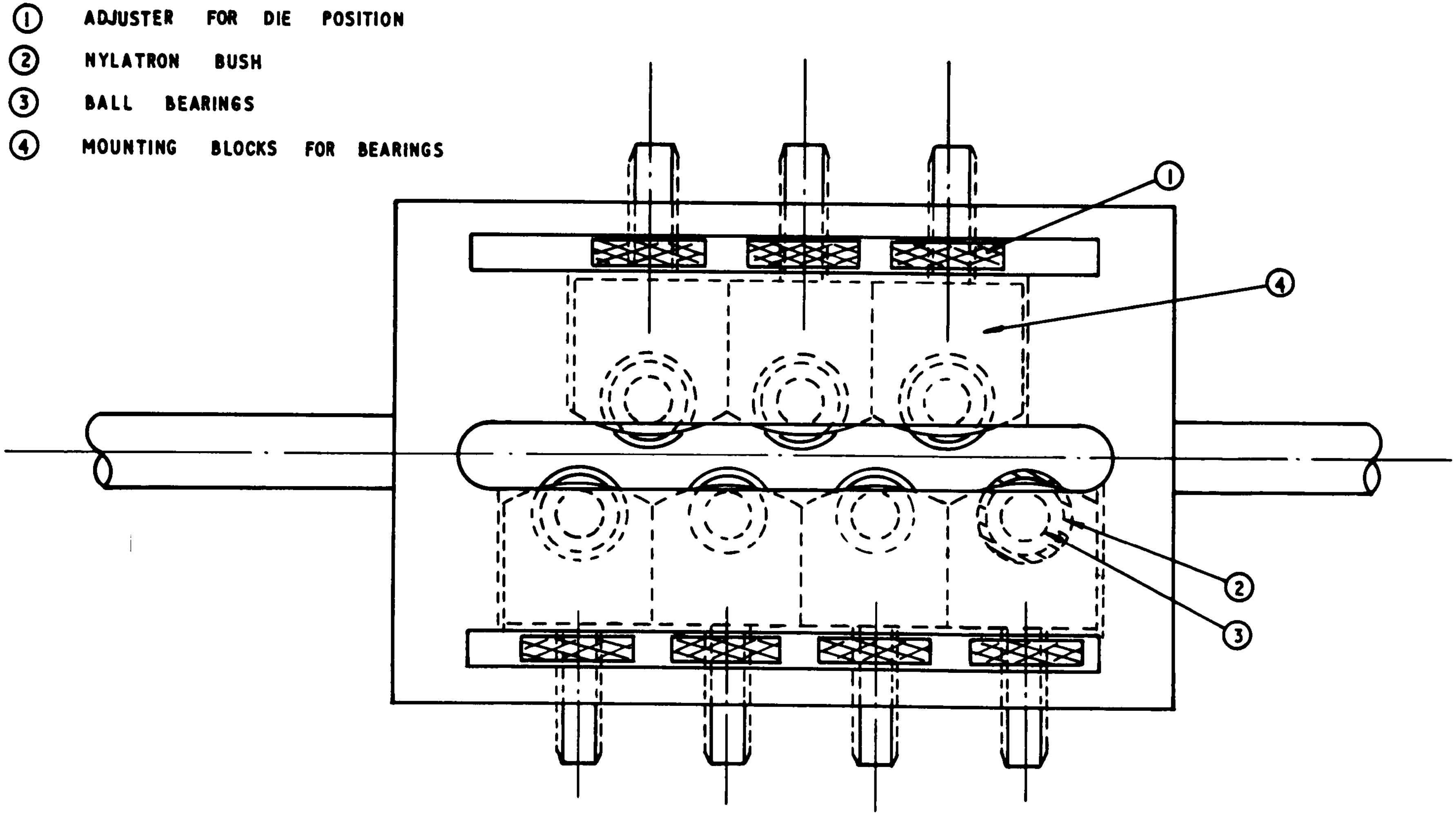
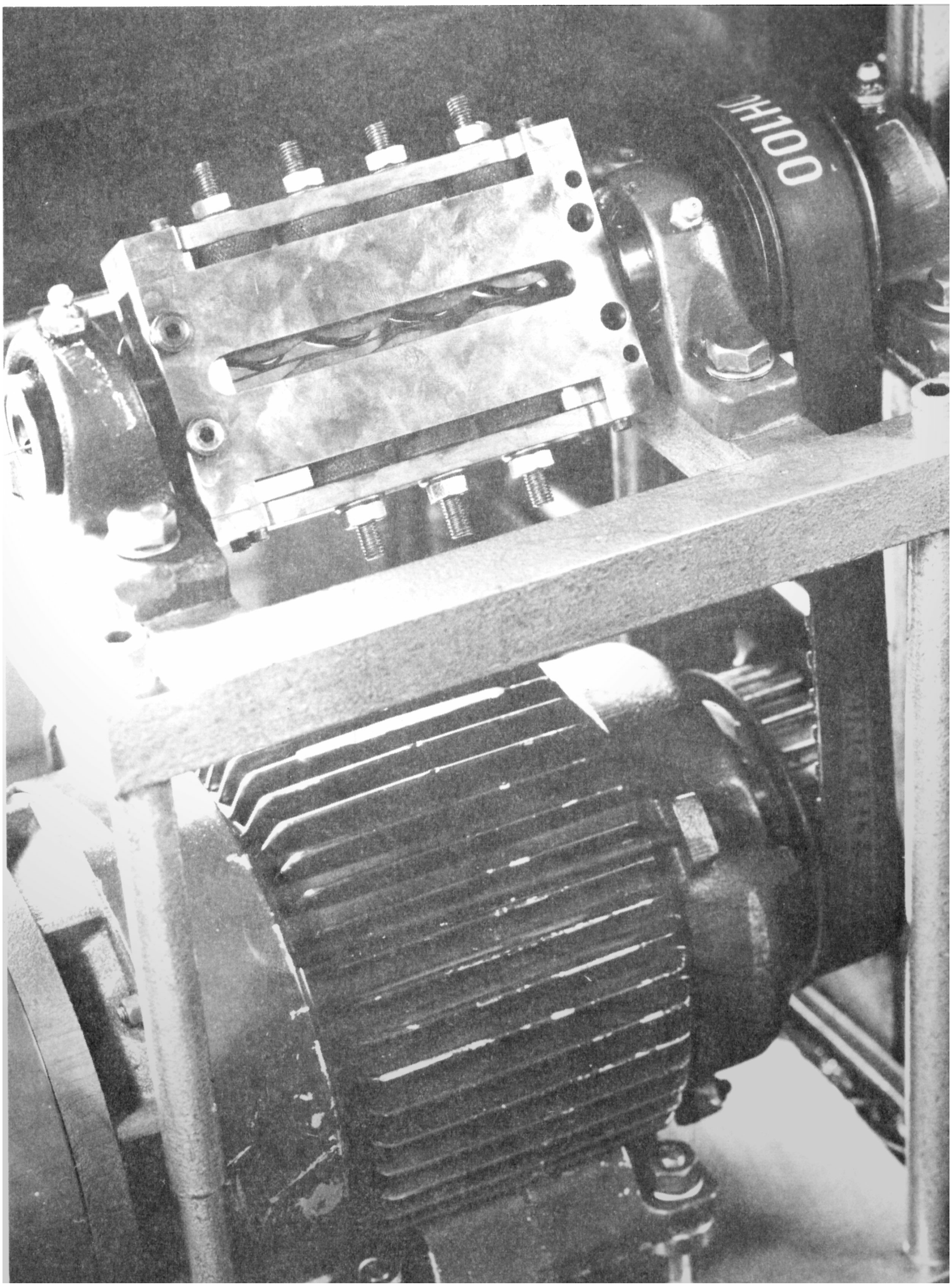


FIG. 1. SPINNER HEAD.

Fig. 2 SPINNER HEAD ATTACHED TO THE COILING MACHINE



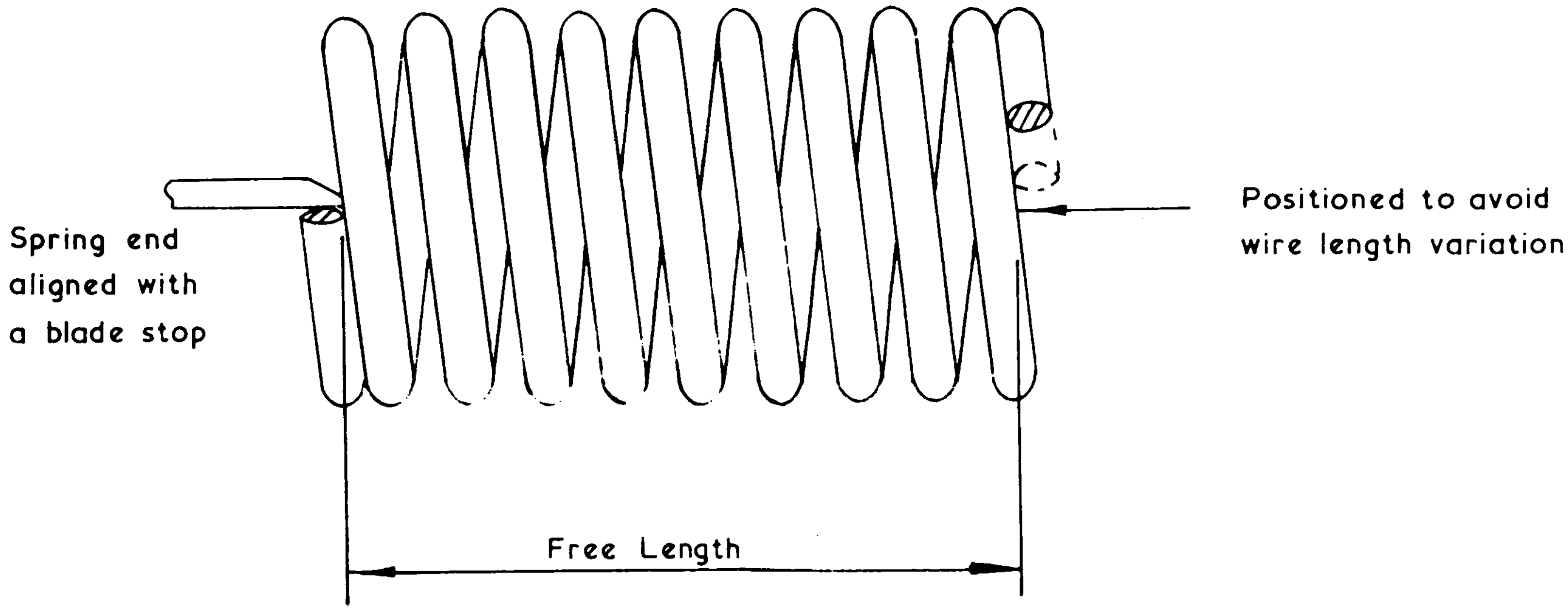


FIG. 3 METHOD OF LOCATING SPRINGS FOR MEASURING