THE SPRING RESEARCH AND MANUFACTURERS' ASSOCIATION

INVESTIGATION INTO PRE SET TOOLING FOR AN AUTOMATIC SPRING COILING MACHINE

by

M.R. Southward B.Sc

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SUMMARY

A feasibility study previously performed by the Association on the setting of coiling machines for repeat orders concluded that although some coiling machines go part way towards solving the problem, none deal with the resetting of the coiling pins.

This present investigation concerns the design of a device to facilitate the resetting of coiling pins. The device produced is a modified face plate for a Wafios UFM8 autocoiling machine wherein all moving parts have recording devices attached, enabling the position of each coiling pin and any necessary adjustment to be recorded quickly and accurately. This device was tested and showed that the variation in coiling tolerances due to resetting are no greater than those caused by different bundles of wire, and that the adjustments necessary to regain the spring design were very small and were mainly concerned with the pitching tool mechanism.

In conclusion the device enabled a very close approximation to the required spring design to be obtained when resetting a coiling machine. Since this device was first designed for laboratory conditions it has now been redesigned and simplified to use in an industrial environment and is presently being tested by one of our member companies.

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1. INTRODUCTION

The result of a feasibility study of pre set tooling on autocoiling machines[1] carried out by the Association showed that some of the adjustable parts on machines are calibrated by the majority of machine manufacturers.

The coiling pin arrangement is the only area common to all machines that does not have any calibrated moving parts, yet this is the most versatile part of the machine. Two devices were suggested by the study as possible solutions to the problem, one of which, termed the "Multi Design", has been selected as the most practical. This device records the position of each moving part in the coiling pin arrangement quickly and accurately. The machine settings may thus be recorded for every spring design and advance warning of a repeat order would not then be necessary.

A two point system has double the possible movements of a single point system so that any pre set tooling device would offer far greater benefits to the former. Consequently a prototype has been built for a Wafios UFM8 autocoiling machine.

The feasibility study explained the problems of resetting coiling machines and concluded that due to uncontrollable variations such as wire properties an identical spring would not be produced on resetting of the machine to the initial calibration values. However, a very close approximation requiring only minor adjustments would be possible. With this in mind this investigation concerns itself with the design and testing of a prototype pre set device.

2. DESIGN OF PROTOTYPE DEVICE

The Wafios UFM8 is a small coiling machine which will produce a spring with a maximum wire size of 0.8 mm. Owing to the restricted space in the coiling area and the necessity of attaching scales of some type to calibrate the movements of the coiling pins without restricting their movement, the prototype device was rather unsightly and fragile. However, the device did satisfy the objective of recording coiling pin positions, and worked well under laboratory conditions.

The prototype model is shown in Figure 1 and the particulars of each moving part of the coiling point assembly along with its recording device are as follows:-

a) To record the rotation of the coiling points a pointer was inserted in a hole drilled through the coiling pin. A protractor was fitted to the rear of the coiling point mounting block to record the position of the pointer.

b) The tilting of the coiling point mounting block was measured by a lever type dial indicator.

c) The mounting block supports which traverse along slides had their screw adjusters replaced by barrel micrometers.

d) The twisting of the lower mounting block support was measured using a protractor and pointer.

3. TESTING PROCEDURE

Various wire samples from different suppliers were obtained in an attempt to ascertain the variations in coiling tolerances and load length characteristics due to differences in wire.

The test programme was divided into three sections as follows:-

i) One bundle of wire was selected and the machine set to produce springs to design number 1 in Table I. 1,000 springs were then produced and the last 10 of every 100 collected. Without altering any part of the coiling pin arrangement or machine settings the bundle of wire was exchanged for another and the procedure was repeated. This was done for a total of six bundles of wire to ascertain the effects of varying wire samples upon the spring produced.

ii) The next test was to coil springs to design number 2 in Table I. As before 1,000 springs were coiled with the last 10 of every 100 collected. The wire was then changed and the machine adjusted to produce a spring to the same design (design no. 2 Table I). The alterations of the coiling machine necessary to reproduce the spring were recorded. This procedure was repeated for a total of nine bundles.

iii) One wire bundle was selected and put on the coiling machine. The pre set device was completely altered arbitrarily and then reset to the previous settings for spring design number 2. 1,000 springs were coiled with the last 10 of every 100 being collected. The pre set device was again completely altered then returned to the original settings and another coiling trial performed. This was repeated for a total of six tests.

On completion of all these tests the collected springs were measured on a Probat electronic load testing machine to measure the loads at the length specified in Table I.

4. RESULTS

In practice we multiply the standard deviation (σ) by a factor of 3 which should encompass a tolerance band of 3σ or 99.7% of the data. To enable a comparison to be made between the measured variation (3σ) with that required to meet industrial specification as calculated from BS 1726 Class B the latter value is included in the Tables II, III and V.

The first coiling trial which shows the variation in springs due to different wire samples is recorded in Table II.

Comparing the coiling tolerances for each sample with the design tolerance shows each sample to be coiling satisfactorily whilst comparison of the average tolerance shows only 83.5% of the springs to be inside the design tolerance.

The variations in load at length for springs of different wire samples but with machine adjustments to produce the same spring design are shown in Table III. These indicate that all springs coiled satisfactorily and that average tolerance was the same as the design tolerance. The adjustments in coiling pin arrangement in order to maintain the design for each wire sample are shown in Table IV. A plus value indicates that a part of the machine was adjusted in the direction such that it will have the effect of increasing the spring dimension controlled by that part. The data in Table IV shows how small the adjustments were to obtain the required spring and that they concerned mainly the pitching tool mechanism.

The final coiling trial indicated variation in spring caused by resetting of the pre set device, the results being shown in Table V. Comparing the coiling tolerance with the specified value shows coiling to be satisfactory for each trial but the average tolerance shows only 82.3% of springs to be inside the specified tolerance. It must be noted at this point that the device was only reset and no adjustments made from the settings to try and obtain a specific spring design, something that would occur in commercial production.

5. DISCUSSION

In general these results for coiling tolerances show the effect of different wires (Table II) to be similar to that of resetting the machine for one particular wire sample (Table V). In an industrial application these two conditions may occur together thus increasing coiling tolerances, but adjustments would be made to retain that spring design and Table IV shows how small these adjustments may need to be.

Having seen that coiling tolerances can be achieved satisfactorily the other factor that must be studied is the mean load for each trial.

This was slightly higher than the design load for the data in both Tables III and V. This increase can be due to variations in many factors, such as number of coils, mean coil diameter, free lengths, wire diameter and end coil formations. Since the wire feed was fixed for all trials and the change in number of coils negligible then the variation in mean coil diameter of the springs was negligible. As the variation in wire diameter was insignificant, the change in mean load is due mainly to a change in free length and/or end coil formation. Using the rate of the spring, the change in free length, assuming no change in end coil formation, may be calculated as 0.64 mm, which can easily be adjusted by the pitching tool mechanism. Similarly changes in end coil formation can easily be eliminated by resetting of cams.

6. CONCLUSIONS

1. Pre set tooling enables an operator to rapidly set a coiling machine to produce a very close approximation of the original spring design for a repeat order.

2. Necessary final adjustments are very small and are usually associated only with the pitch tool mechanism.

3. The variation due to resetting the device is generally no greater than that normally experienced when changing a bundle of wire.

7. MODIFICATIONS TO DEVICE FOR INDUSTRIAL APPLICATION

The results of this investigation indicate the theory behind the pre set device to be satisfactory. Consequently the device has been modified into a more practical and simpler item of equipment (Fig. 2), by means of the following improvements.

a) The position of the dial test indicators was changed to enable them to lie flat close to the mounting plate.

b) The method of recording the rotation of the coiling point was changed from a pointer/protractor assembly to a cam/dial test indicator method.

c) The mounting block for the coiling point was redesigned (Fig. 3), to enable the coiling points to be changed and replaced in the correct rotational position relative to the dial test indicator reading. Also the rotation of the coiling point was made simple by the use of a lever.

d) A Vernier type scale was attached to the adjuster to record depth of the coiling pin in the mounting block, enabling coiling pins to be replaced at the same depth as used previously without altering the barrel micrometer readings.

8. REFERENCE

1. Southward, M.R. "A feasibility study of jig set tooling for automatic spring coiling machines". SRAMA Report 270, December 1976.

TABLE I SPRING DESIGNS

Spring Design No.	1	2
Wire Diameter (mm)	0.71	0.71
Mean Coil Diameter (mm)	4.29	9.29
Spring Index	6.04	13.08
Active Coils	5.5	7.5
Total Coils	7.5	9.5
Free Length (mm)	13	19.3
Load at length (N)	21.0	3.37

TABLE II COILING VARIATIONS DUE TO DIFFERENT WIRE SAMPLES

	Bundle Numbers						
	1	2	3	4	5	6	
Tensile Strength (N/mm^2)	2505	2478	2344	2668	2271	2470	Overall Values
Mean Load (N)	22.07	21.22	19.82	20.04	23.91	20.80	21.31
Short term variation (σ)	0.20	0.14	0.20	0.25	0.29	0.24	
(3σ)	0.60	0.42	0.60	0.75	0.87	0.72	
Long term variation (σ)	0.21	0.16	0.36	0.26	0.30	0.29	1.51
(3σ)	0.63	0.48	1.08	0.78	0.90	0.87	4.5
BS1726 Tolerance							2.1
Quantity of springs inside BS 1726 tolerance							83.5%

TABLE III COILING VARIATIONS DUE TO RESETTING OF COILING MACHINE

	BUNDLE NUMBERS								
Tensile Strength (N/mm^2)	1	2	3	4	5	7	8	9	Overall Values
	2505	2478	2344	2668	2271	2558	2617	2639	
Mean Load (N)	3.41	3.37	3.44	3.43	3.32	3.40	3.69	3.47	3.44
Short term variation (σ)	0.12	0.05	0.13	0.12	0.12	0.04	0.08	0.10	
(3σ)	0.36	0.15	0.39	0.36	0.36	0.12	0.24	0.30	
Long term variation (σ)	0.13	0.07	0.18	0.14	0.12	0.07	0.08	0.13	.11
(3σ)	0.39	0.21	0.44	0.42	0.36	0.21	0.24	0.39	.34
BS 1726									.33

TABLE IV ADJUSTMENTS TO COILING MACHINE

Cam Controlling first coil (deg)	Cam Controlling last coil (deg)	Depth of second coiling point (mm)	Pitch tool (mm)
+ 1	+ 3	+ 0.02	- .25
+ 1	+ 3	+ 0.02	- .25
+ 1	+ 3	+ 0.02	- .25
+ 2	+ 1	- 0.09	+ .50
+ 1	+ 2	+ 0.27	- .25
+ 1	+ 1	+ 0.11	- .50
+ 1	+ 1	+ 0.20	- .25
+ 1	+ 2	+ 0.15	- .25

TABLE V COILING VARIATIONS DUE TO RESETTING OF PRE SET DEVICE

	Original results	TRIAL NUMBER 1	2	3	4	5	6	Overall Values
Mean load (N)	3.32	3.45	3.46	3.57	3.62	4.10	3.84	3.62
Short term variation (σ)	.12	.046	.049	.048	.048	.054	.056	
(3σ)	.36	.14	.15	.14	.14	.16	.17	
Long term variation (σ)	.12	.057	.062	.057	.056	.068	.067	.27
(3σ)	.36	.17	.19	.17	.19	.20	.20	.80
BS 1726 tolerance								0.33
Quantity of spring inside BS 1726 tolerance								82.3%

FIG.1. PROTOTYPE DEVICE

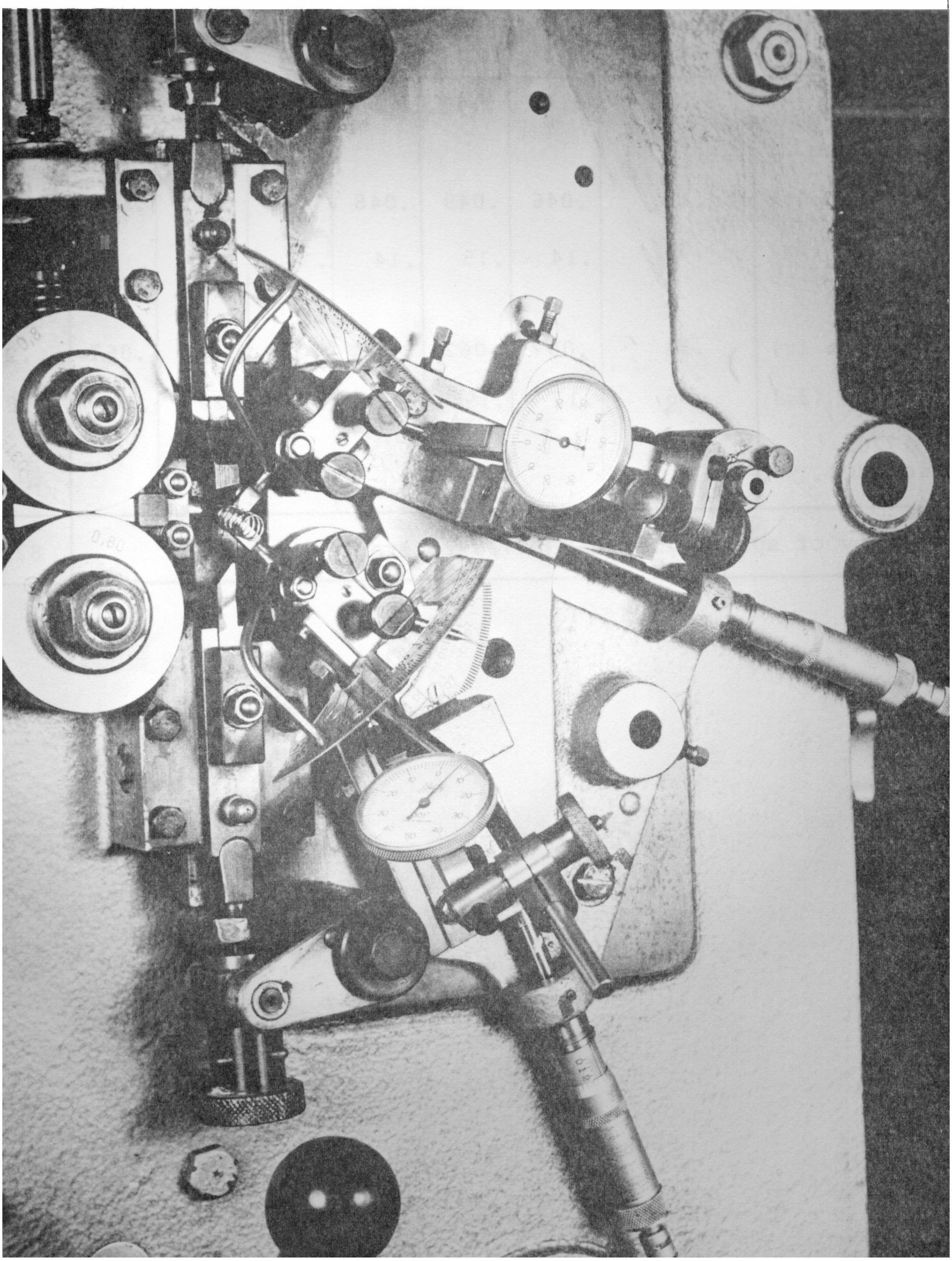

FIG.2. MODIFIED DEVICE

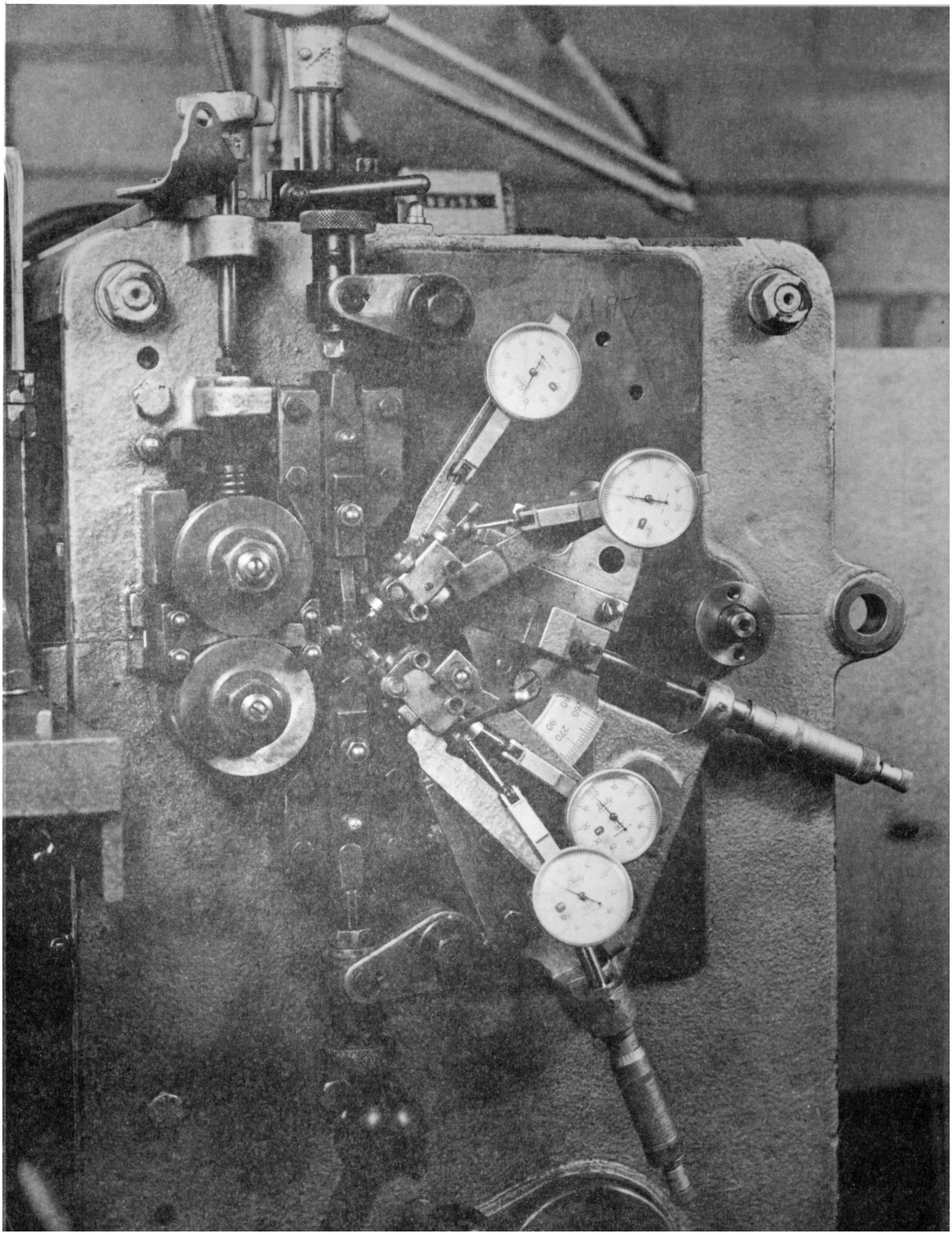

FIG. 3 MOUNTING BLOCK FOR COILING POINT