THE SPRING RESEARCH AND MANUFACTURERS' ASSOCIATION

A SURVEY OF PRODUCTION SPEEDS FOR THE COILING AND GRINDING OF COMPRESSION SPRINGS

Report No 398

by

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SUMMARY

Production speed is one of the most influential factors on the profitability of a manufactured item. Consequently, accurate estimation of a spring's speed of production at the quotation stage is essential in order to avoid making a loss.

This report covers a survey to determine the average production speeds for auto coiling and grinding operations in the manufacture of compression springs. In addition, comparing quoted and recorded production speeds has shown that, in general, the industry performs better than it quotes. The data collected by the survey were analysed and indicated that the most significant features of a spring design influencing coiling production speeds were wire diameter and wire length, whereas only wire diameter had an apparent influence on grinding speed. The data were subsequently plotted in various formats to enable manufacturers both to compare their performance with the industry average and to aid them at the quotation stage with practical data for estimating production speeds.

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1. INTRODUCTION

There are many factors which affect manufacturing costs in the spring industry, but one of the most influential is the speed at which a spring is produced. The higher the speed, the lower the cost, and so ideally all springs should be produced at the maximum possible speed. In addition, accuracy in the estimating of production speeds at the quotation stage is essential to maintain a company's competitiveness.

This survey was performed in order to determine the average production speeds for auto coiling and grinding across a representative sample of the spring industry. This should enable companies to compare their performance with the norm for the rest of the industry. The survey also examined the accuracy of estimated production speeds by comparing recorded with quoted speeds and generating an overall performance for the industry. Finally, the collected data were analysed to determine which features of a spring design significantly influence the speed at which it can be produced.

2. PROCEDURE

Ten companies representing a range of both size and product type were visited in order to complete a questionnaire, the headings of which are listed below.

Material

Wire diameter

Outside diameter and tolerance

Free length and tolerance

Total coils

Rate and tolerance

Loads at lengths and tolerance

Recorded production speed

Quoted production speed

The form was filled in with production rates measured while touring the shop floor thus providing a "snapshot" of actual production at the time of the visit.

3. RESULTS

The survey collected data for the coiling of fifty-two spring designs encompassing five different materials, while data for the grinding operation covered seventeen spring designs and four materials. The breakdown of data collected against material is shown in Table I.

The two features of spring index and wire length were calculated for each spring design and have been listed in Table II along with wire diameter, recorded speed, performance relative to estimated speed and an assessment of tolerances relative to BS 1726. Table III has been similarly constructed for the survey data on grinding, although the only feature calculated was spring index. From the data in these two tables the average speeds were determined as 4093 sph for coiling and 2786 sph for grinding.

Data have been plotted on Figures 1 to 3 for wire diameter, wire length and spring index respectively to relate these features to the recorded coiling production speed. For grinding Figures 4 and 5 have similarly been plotted for wire diameter and spring index respectively.

4. DISCUSSION

With regard to the coiling operation, the survey has shown that the production speed was 4093 springs per hour. The industry operates at a production speed 5% higher than quoted, although the actual figures range from + 200% to - 32%. From the ten companies included in the survey, seven had at least one job running at less than 95% of the quoted speed. Studying Figures 1 and 2 indicates the influence of both wire diameter and wire length upon production speed - the larger the former and the longer the latter, the slower the production speed. However, Figure 3 would indicate that spring index does not have any effect upon speed of production.

The survey has shown the average grinding production speed for the average production speed for the industry as 2786 springs per hour and that the industry operates at speeds 22% faster than quoted, although individual cases may vary from + 116% to - 63%. Figures 4 and 5 indicate that an increase in wire size reduces the production speed, and that spring index has no apparent influence on speed of production.

The figures produced by the survey will enable springmakers to compare their production speeds with the average speed for the industry. Also, by isolating wire diameter and wire length from any spring design, a manufacturer can compare his production speed for that design with the speed for other designs containing similar characteristics. He can then compare his performance with the rest of the industry and decide whether, on average, he produces springs faster or slower than his counterparts. Such comparisons will highlight those designs whose production appears to be slow, the reasons for which should be isolated and analysed to determine their legitimacy.

The figures produced from the survey can also be used as a guide when estimating the production speed for a spring design at the quotation stage. However, final adjustment will have to be made to any production speed determined in this manner, to make allowances for the capabilities of the machine on which the spring is to be produced.

5. CONCLUSIONS

1. From the survey the average production speed was determined as 4093 springs per hour for coiling and 2786 springs per hour for grinding.

2. In general, the industry operates faster than estimated production speeds by 5% for coiling and 22% for grinding. It is thus, by and large, taking account of the factors that influence production speeds.

3. The survey indicates that the major factors which influence the coiling speeds are wire diameter and wire length. For the grinding operation, only wire diameter has an apparent influence on production speed.

TABLE I BREAKDOWN OF DATA AGAINST MATERIAL

COILING DATA

Material Code	Material Type	Quantity of Designs
1	Patented Carbon	37
2	Stainless	10
3	Chrome Vanadium	3
4	Silicon Chrome	1
5	Phosphor Bronze	1

GRINDING DATA

Material Code	Material Type	Quantity of Designs
1	Patented Carbon	13
2	Stainless	2
3	Chrome Vanadium	1
4	Phosphor Bronze	1

TABLE II SURVEY DATA FOR COILING COMPRESSION SPRINGS

Material Code	Wire Dia	Spring Index	Wire Length	Recorded Speed	Percentage Performance	Tolerance tighter than BS1726
1	.38	12.5	120	4500	29	Yes
1	.51	11.3	219	5508	-8	Yes
1	.51	6.7	163	3600	20	
1	.58	12.3	142	6816	-3	
1	.61	8.6	235	4860	22	
1	.61	9.0	251	4680	17	
1	.71	8.3	67	4850	21	
1	.71	6.1	228	6000	50	
1	.71	13.3	150	2568	-5	
1	1.02	8.1	635	2220	-26	Yes
1	1.02	13.3	128	4728	43	
1	1.02	8.8	194	2000	0	
1	1.02	24	77	7200	-10	
1	1.12	12.3	701	2030	-32	
1	1.19	10.3	156	6180	3	Yes
1	1.22	10.9	713	3000	——	
1	1.3	8.2	365	4680	17	
1	1.42	19.0	1023	1100	10	
1	1.42	4.8	1297	1320	32	Yes
1	1.5	10.9	179	6600	-8	
1	1.63	8.8	227	2210	10	Yes
1	1.63	5.7	89	3780	51	
1	1.63	5.7	89	2400	60	
1	1.77	8.6	443	3000	20	Yes
1	1.8	22	489	3720	——	
1	2.03	15.8	405	1140	-24	
1	2.03	19.2	708	1836	2	
1	2.08	5.7	141	3480	5	Yes
1	2.4	9.8	669	2244	12	Yes
1	2.64	27.8	11524	200	77	
1	2.64	2.9	63	3000	0	
1	3.35	15	1785	2064	-2	
1	3.40	33	3372	564	——	
1	3.5	4	217	5400	0	
1	3.96	4	201	4000	21	
1	5	6.7	1060	2000	-22	
1	6.35	7.7	1005	1200	-5	
2	.17	90	608	15000	0	
2	.18	73	668	17760	4.5	
2	.254	10.6	170	2760	-32	
2	.254	13	130	2080	39	
2	.304	21	208	3500	75	
2	.457	7	128	7584	8	
2	.508	22	198	5180	4	
2	1.02	6.5	272	6085	——	
2	1.02	15.4	817	3900	-22	
2	1.63	8	411	2715	13	
3	3.5	4	217	5400	0	
3	3.66	7.6	637	3600	80	
3	4.37	6.3	689	2000	-25	
4	3.66	4.6	556	600	200	
5	.229	11.6	155	8000	0	

TABLE III SURVEY DATA FOR GRINDING COMPRESSION SPRINGS

Material Code	Wire Dia.	Spring Index	Recorded Speed	Percentage Performance	Tolerance tighter than BS 1726
1	.81	9.1	1920	7	yes
1	.81	8.2	4865	--	
1	.91	6.6	4752	116	
1	1.22	11	3000	--	
1	1.22	4.4	2620	9.2	yes
1	1.42	8.3	3557	62	
1	1.50	4	1543	--	
1	1.50	10.8	4000	60	
1	1.63	6.5	1509	-37	
1	2.34	8.9	2314	--	
1	2.34	7.9	733	-63	
1	3.25	3.2	2400	--	
1	3.66	8.9	1470	--	yes
2	1.02	6.5	6085	--	
2	1.83	7.9	2175	--	
3	3.50	4.1	2304	-23	
4	3.66	7.6	2118	-26	

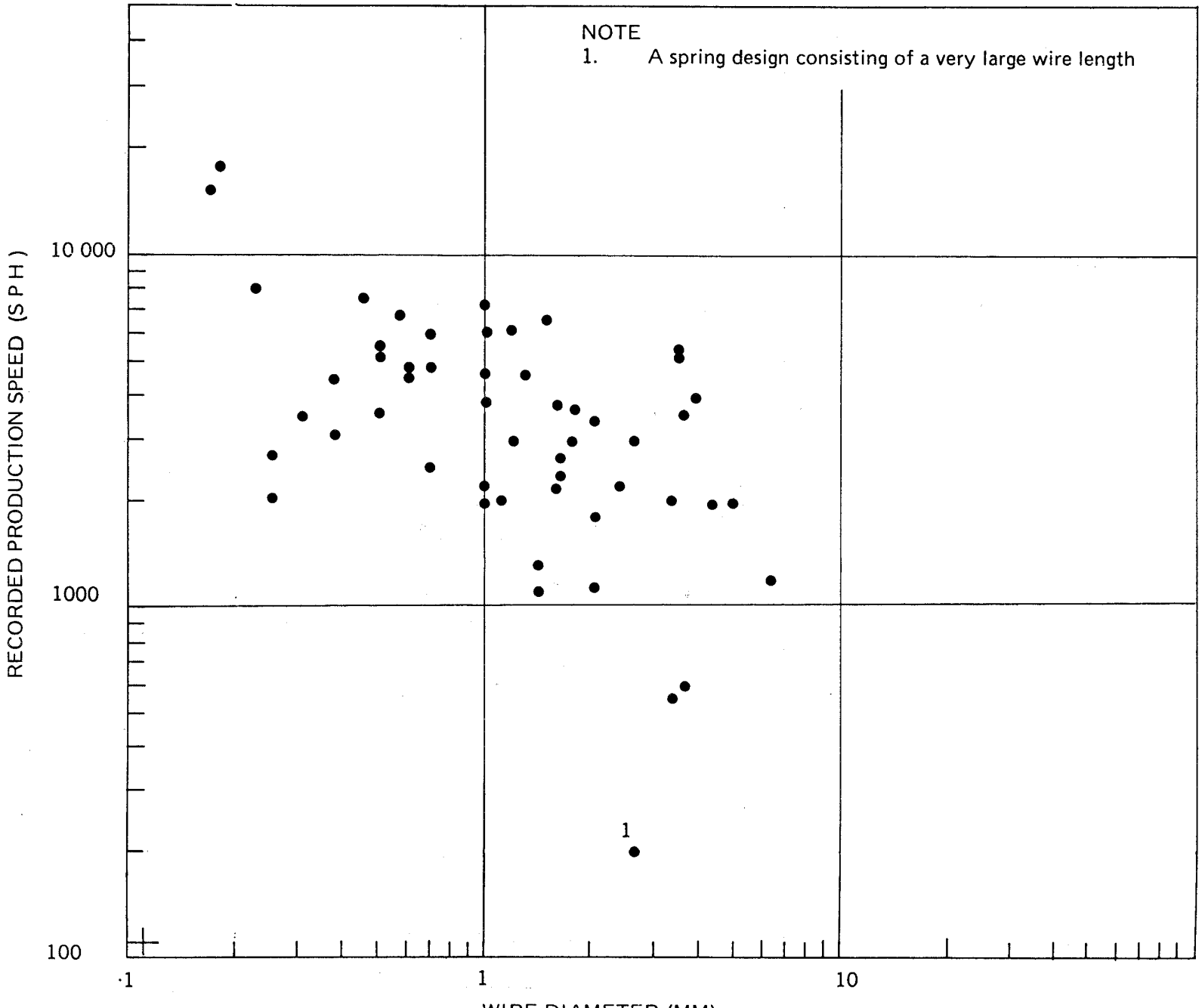

FIG 1: RECORDED PRODUCTION SPEED FOR COILING AGAINST WIRE DIAMETER

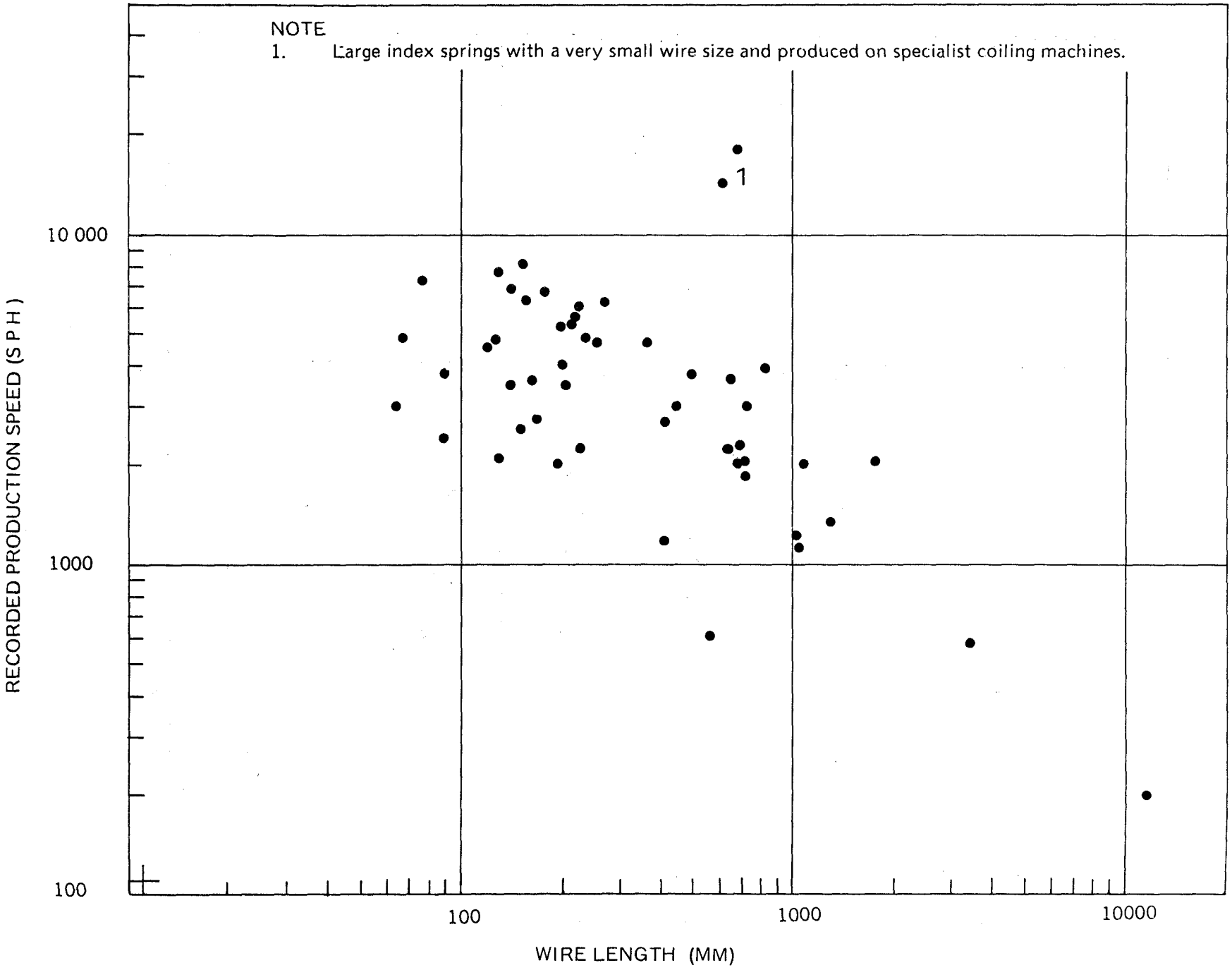

FIG 2 RECORDED PRODUCTION SPEED FOR COILING AGAINST WIRE LENGTH

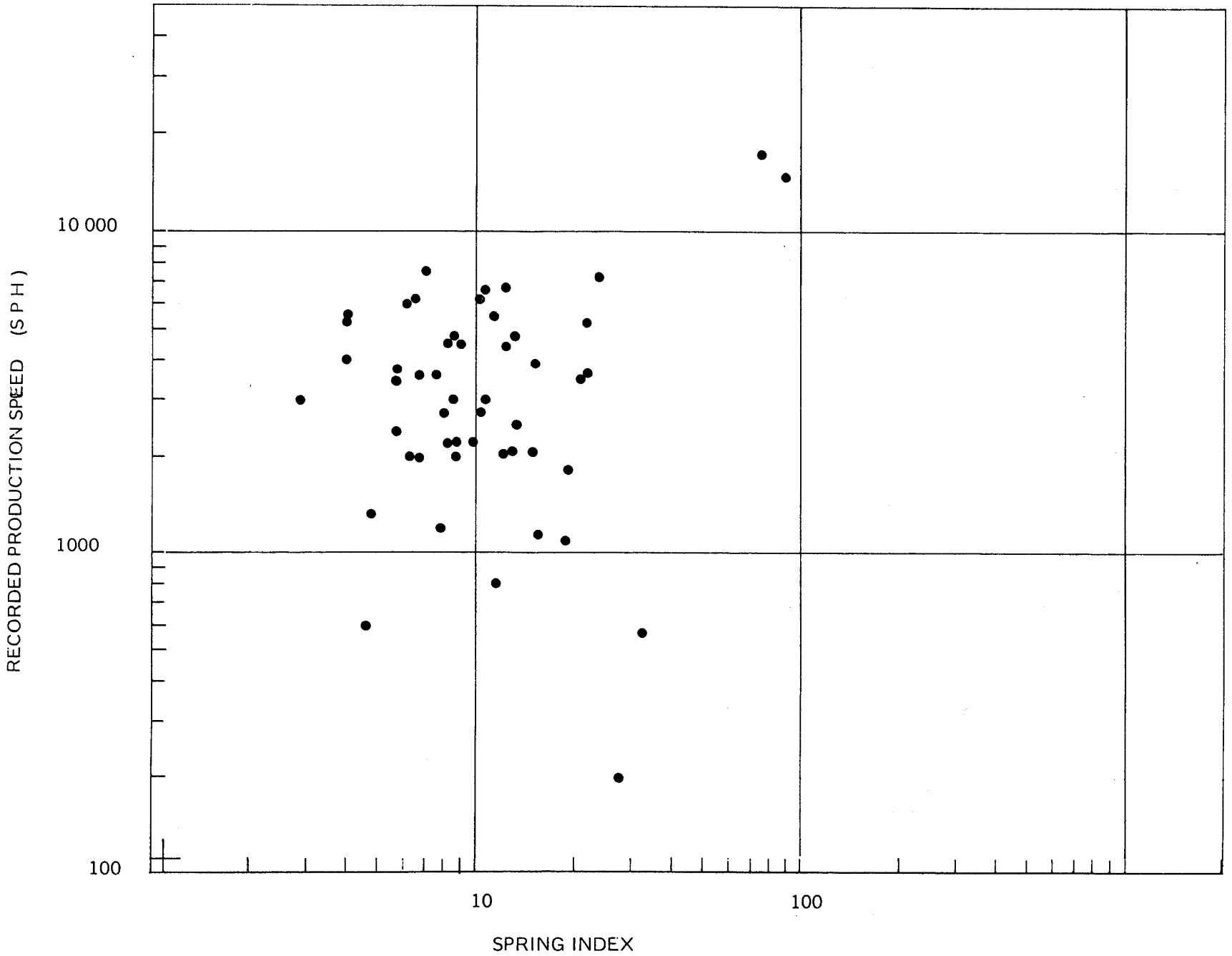

FIG:3 RECORDED PRODUCTION SPEED FOR COILING AGAINST SPRING INDEX

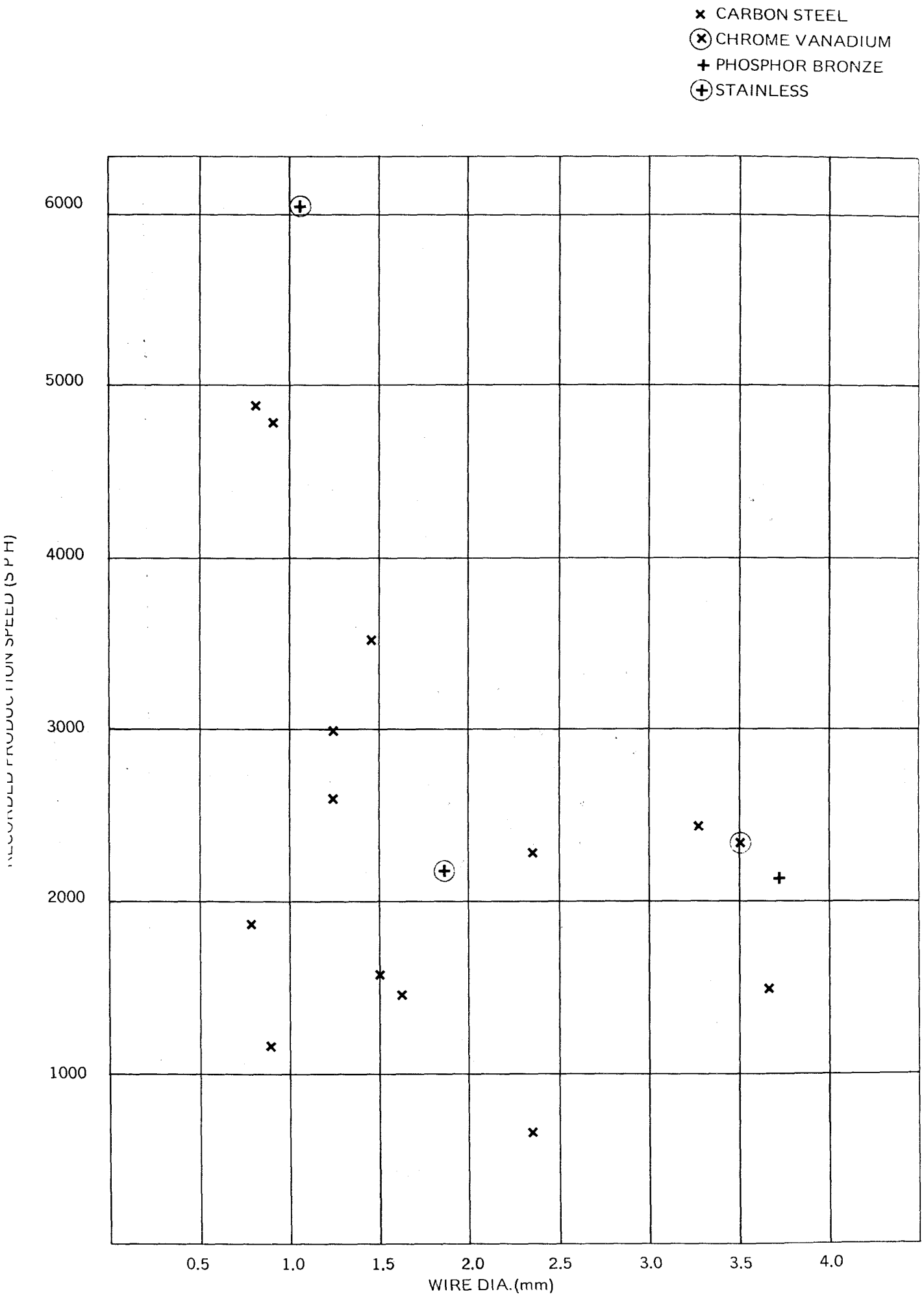

FIG:4: RECORDED PRODUCTION SPEED OF GRINDING AGAINST WIRE DIAMETER

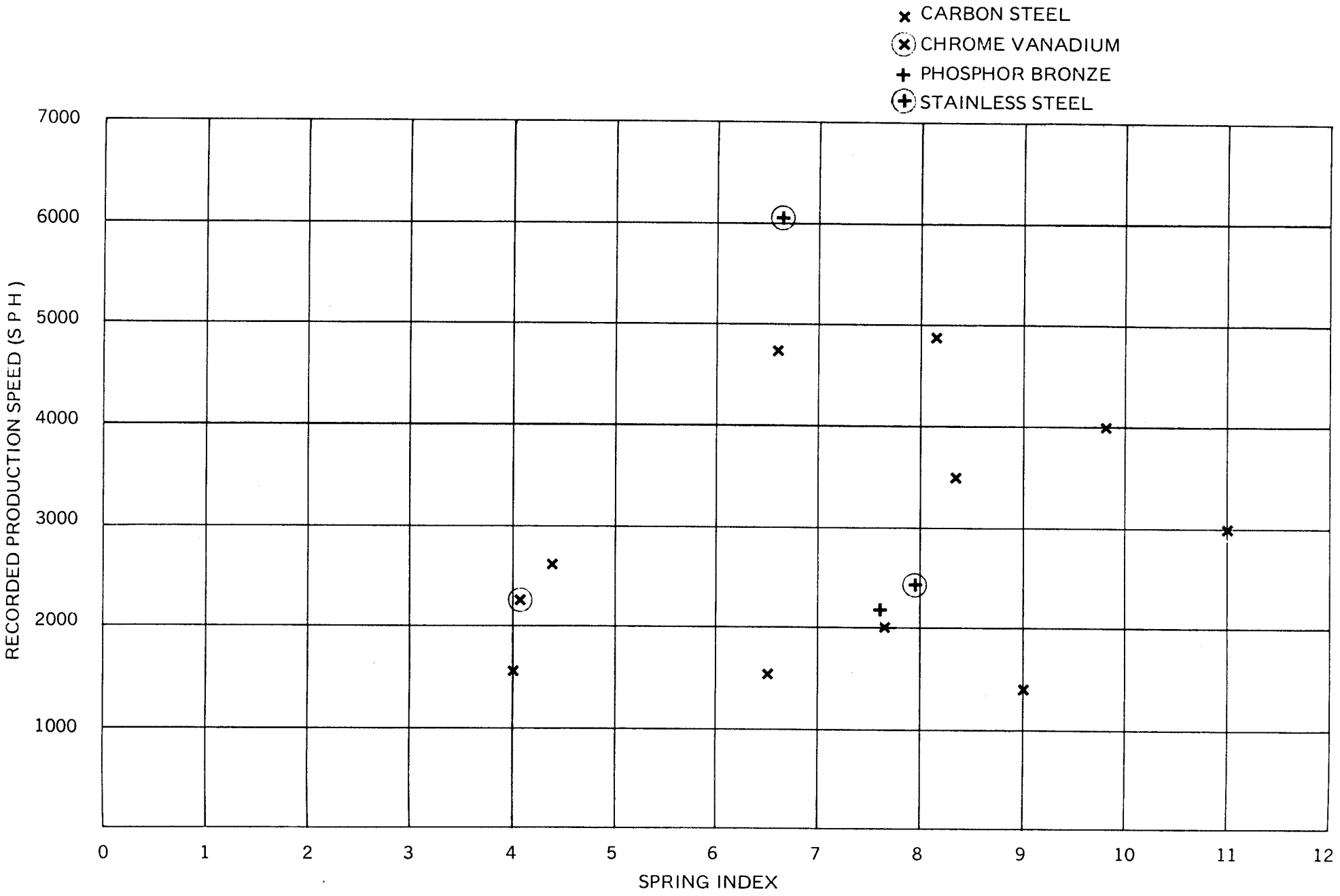

FIG 5: RECORDED PRODUCTION SPEED OF GRINDING AGAINST SPRING INDEX.