

DON'T DISCLOSE IDENTITIES

From the beginning of these studies, the identities of the persons under study have been kept confidential. We look to you to carry on this trust. Please guard the privacy of the persons involved by substituting fictitious names, or code symbols for real names.

3
QUALITY OF PRODUCTION
RELAY ASSEMBLY TEST ROOM

12 P
6/16/30 to 4/24/31

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OUTLINE

QUALITY OF PRODUCTION - RELAY GROUP

1. Purpose of study; source of material.
2. Quality of production - percent passing inspection.
3. Classification of defects which cause rejection.
 - 3.1 Defects of assembly, operators responsible.
 - 3.2 Defective Parts, operators responsible.
 - 3.3 Defective parts, operators not responsible.
 - 3.4 Miscellaneous defects.
4. Share of each girl in group performance.
5. Explanation of attached sheets 4A to 4D. (Summaries of Source Material)
6. Discussion of attached sheets:
 - 6.1 Rejections for which operators are responsible.
 - 6.2 Rejections due to screwdriver action.
 - 6.3 Rejections due to incorrect assembly.
 - 6.4 Rejections due to defective parts.
7. A.M. vs. P.M. rejections.
8. Principal causes of rejections.
9. Assembly characteristics of each operator.
 - 9.1 Operator 1
 - 9.2 Operator 2
 - 9.3 Operator 3
 - 9.4 Operator 4
 - 9.5 Operator 5

QUALITY OF PRODUCTION - RELAY GROUP

1. Measures of the production of the operators in the Relay test room have heretofore been made chiefly in terms of the quantity of output. It is desirable also to secure a measure of the quality of the work done by these girls, and as a preliminary step in this direction, on June 16, 1930, a new type of record was originated. Sheets listing the twenty-three defects most frequently causing rejection of a relay by the inspector were drawn up and multigraphed, and on the date mentioned the inspector began recording the kind of defect, the hour of assembly, and the operator for each rejection. The study herein described gives a summary of the records of the inspector for forty-three weeks (6-16-30 to 4-24-31) and is intended as a preliminary view of the quality of work done by these operators. Subsequent studies will be made of the relation of various factors to the quality of production.
2. During the forty-three week period studied a total of 9688 relays were returned to the operators for repair. This is an average of 45 rejections per operator per week. The average weekly output per operator was 2280 relays. By division we find that 98.0% of all relays assembled passed inspection, and that 2.0% were rejected.
3. The twenty-three kinds of defects listed on the inspector's record may be grouped under three headings: (1) "Defects of Assembly, Operators Responsible"; (2) "Defective Parts, Operators Responsible"; and (3) "Defective Parts, Operators not Responsible".

- 3.1 Defects of assembly involve 41% of all defective relays. These defects may be due to carelessness in handling the automatic screwdriver, as screws burred and screws stripped; or they may be due to incorrect assembly of parts, as wrong springs, wrong armature, wrong coil, wrong assembly, insulators missing, insulators assembled wrong, springs missing, terminal missing, and bushing broken (due to irregular pile-up of parts).
- 3.2 About 57.5% of rejections are due to the inclusion of parts which come to the operators defective. Some of these defects are obvious, and failure to reject them is clearly the fault of the operator. This group of defects (Group 2) constitutes 38% of all rejections and includes wrong or missing contacts, broken insulators, terminals broken or not tinned, adjusting nut missing, armature disc missing or damaged, and damaged coil.
- 3.3 Other defects can be seen only as a result of close inspection, or are subject to decisions involving judgment. These defects cause 22.5% of all rejections, and while the operators sometimes see and discard such parts, yet they are not fully responsible for failure to do so. This group (Group 3) includes damaged springs, adjusting nut loose, and armature cracked, bent, or damaged.
- 3.4 A few defects occur so infrequently as not to be classified on the inspector's sheets. These are listed as "Miscellaneous" (Group 4) in this study and constitute 1.5% of all rejections.
4. The following table is based on the relation of each girl's performance to group performances. The share each girl had in the

total group output for the forty-three weeks of this study is here shown, together with her share in the rejections of the group:

TABLE 1
Percent of Group Performance for each Operator

Operator	Production	Defects				Total Defects
		Operators Responsible			Total	
		Screw-driver	Incorrect Assembly	Defective Parts		
1	20.4	18.9	25.1	20.4	21.7	20.6
2	22.4	21.5	25.1	20.0	28.6	26.7
3	19.2	16.2	21.8	18.2	19.1	19.5
4	19.5	20.8	8.5	11.4	12.1	12.8
5	18.5	12.6	19.7	20.0	18.5	18.4
Group	100.0	100.0	100.0	100.0	100.0	100.0

The rejections of Operators 1, 3, and 5 bear about the same relation to group rejections as does their production, while Operator 2 has a disproportionately large share of rejections, and Operator 4 a very small share. Operator 2 is the fastest and the least accurate assembler of the group. Her greatest difficulty is with the automatic screwdriver, but she is high in other defects as well. Operator 4, though having the smallest share in all other classes of defects, ranks second to Operator 2 in screwdriver defects. Operators 3 and 5, the slowest assemblers in the group, are both leisurely in their use of the automatics, and show proportionately less defects due to that cause.

5. The attached Sheet 4A shows a summary of defects classified as described above. Such defects in each group as involve a very small percentage of rejections are grouped under "Other." Totals are shown for each operator for the forty-three week period, by A.M., P.M., and day. Sheet 4B shows the same divisions, but the figures are here given as percentages of the operator's total for the period involved. Sheet 4C gives the totals for each group of defects as outlined in paragraph 5, Page 1, and 4D gives the percentages for this division.

6.1 As shown on Sheet 4D, operators may be regarded as responsible for 76% of their defective relays. Some of the operators are responsible for a larger percentage of their own defects than this, some for a smaller. The responsibility is as follows:
(See Sheets 4C and 4D.)

<u>TABLE 2</u>		
<u>Operator</u>	<u>No. of her rejections for which she is responsible.</u>	<u>Percent of her total rejections</u>
1	1608	80.6%
2	1361	76.3%
3	2107	75.7%
4	1406	74.3%
5	892	71.7%
Group	<u>3006</u>	<u>76%</u>

As shown in Sheets 4A and 4C, Operator 4 has had only 1345 rejected relays during this period out of a total of 9000 for the five operators, and the above table shows that she is responsible for a smaller percentage of her rejections than are any of the other operators.

TOTAL DEFECTIVE RELAYS
FORTY-THREE WEEKS
4-16-50 TO 4-24-51

4A.
Relay Test Room.

Operators Responsible

Oper.	Assembly (1)							Parts (2)			Operators Not Responsible (3)		(4)	Total
	Screws Burred	Screws Stripped	Ins. Miss.	Assm. Wrong	Springs Wrong	Bushings Broken	Other	Converts Wrong or Missing	Ins. Broken	Other	Springs Damaged	Other		
A.M.														
1	85	68	116	64	52	67	27	194	154	96	185	27	15	1126
2	151	104	89	85	55	123	30	270	283	54	520	58	19	1821
3	55	70	68	57	63	90	19	251	90	48	245	24	7	1087
4	86	84	33	19	23	23	22	106	74	43	166	26	16	721
5	38	54	87	37	75	52	11	257	103	35	194	57	5	1008
Total	595	380	393	260	266	355	109	1078	664	278	1110	191	60	5528
P.M.														
1	80	56	101	70	54	70	22	124	108	37	112	30	16	859
2	120	89	94	54	30	54	31	177	191	43	199	44	36	1162
3	28	65	61	85	51	44	22	140	62	27	164	32	11	802
4	59	64	25	72	12	32	9	85	51	26	112	19	14	524
5	51	54	102	41	44	45	12	171	88	25	133	29	7	783
Total	507	328	381	262	197	245	96	697	501	158	720	154	64	4130
TOTAL														
1	142	124	217	134	106	137	49	318	242	133	297	57	29	1985
2	251	193	183	137	85	177	61	447	474	98	519	102	55	2733
3	83	135	129	142	114	134	41	391	152	75	409	56	18	1869
4	145	148	58	31	41	58	31	191	125	69	278	45	30	1245
5	89	108	189	72	117	97	23	428	192	60	327	86	12	1782
Total	700	708	774	528	433	600	205	1772	1125	436	1320	346	144	9683

PERCENTAGE OF TOTAL DEFECTS IN EACH CLASSIFICATION
FORTY-THREE WEEKS
6-16-30 TO 4-24-31

43.
 Relay Test Room.

Oper.	Operators Responsible							Parts (2)			Operators not Responsible (3)			Total
	Assembly (1)				Springs Wrong	Bush. Broken	Other	Contacts Wrong or Missing	Ins. Broken	Other	Springs		(4)	
	Screws Burred	Screws Stripped	Insul. Missing	Insul. Assm. Wrong							Dam- aged	Other		
A.M.														
1	7.4	6.0	10.5	5.7	4.6	6.0	2.4	17.2	11.9	8.5	16.4	2.4	1.2	100.0
2	8.1	6.4	5.5	5.1	5.4	7.6	1.8	16.6	17.5	5.5	19.7	5.6	1.2	100.0
3	5.1	6.5	6.5	5.2	5.8	8.3	1.7	23.1	8.3	4.4	22.8	2.2	.6	100.0
4	12.9	11.7	4.6	2.6	3.2	3.1	3.1	14.7	10.3	6.0	25.0	3.6	2.2	100.0
5	5.8	5.4	8.7	3.7	7.2	5.2	1.0	25.7	10.5	3.5	19.4	5.7	.4	100.0
Total	7.1	6.8	7.1	4.7	4.8	6.4	1.9	19.4	12.3	5.0	20.0	5.4	1.1	100.0
P.M.														
1	6.9	6.5	11.8	8.1	6.5	8.1	2.6	14.4	12.6	4.5	15.0	3.5	1.9	100.0
2	10.5	7.7	8.1	4.7	2.6	4.6	2.7	15.2	16.4	3.7	17.1	3.8	3.1	100.0
3	4.7	8.1	7.6	10.6	8.4	5.5	2.7	17.5	7.7	3.4	20.4	4.0	1.4	100.0
4	11.5	12.2	4.4	2.5	3.4	6.1	1.7	16.2	9.7	5.0	21.4	3.6	2.7	100.0
5	4.0	6.9	15.0	5.2	5.6	5.8	1.5	21.9	11.3	3.2	17.0	3.7	.9	100.0
Total	7.4	7.9	9.2	6.3	4.8	5.9	2.3	16.9	12.4	3.6	17.4	3.7	2.0	100.0
TOTAL														
1	7.2	6.2	10.9	6.7	5.5	6.9	2.5	16.0	12.2	6.7	15.0	2.9	1.5	100.0
2	9.0	6.9	6.6	4.9	3.1	6.4	2.2	16.1	17.0	3.5	18.6	3.7	2.0	100.0
3	4.9	7.1	6.8	7.5	8.0	7.1	2.2	20.7	8.0	4.0	21.7	3.0	1.0	100.0
4	11.6	11.9	4.5	2.5	3.3	4.4	2.5	15.3	10.1	5.4	22.3	3.6	2.4	100.0
5	3.9	6.0	10.6	4.4	6.5	5.4	1.3	24.0	10.8	3.3	18.5	4.8	.7	100.0
Total	7.2	7.3	8.0	5.4	4.8	6.2	2.1	18.5	12.2	4.5	18.9	3.6	1.5	100.0

6.2 Sheet 4D further reveals that defectives caused by carelessness in handling the screwdriver are as follows:

TABLE 3

<u>Operator</u>	<u>No. of Rejections due to Screwdriver</u>	<u>Percent of her total Rejections</u>
4	293	25.8%
3	444	15.8%
1	266	13.4%
5	228	12.8%
2	177	9.8%
<u>Group</u>	<u>1408</u>	<u>14.8%</u>

It will be observed that almost one-fourth of all Operator 4's rejections are due to faulty use of automatic screwdriver.

6.3 The defects due to careless selection and placement of parts in assembly are as follows:

TABLE 4

<u>Operator</u>	<u>No. of Rejections due to Incorrect Assembly</u>	<u>Percent of her total Rejections</u>
1	643	22.5
3	540	20.6
5	504	20.2
2	643	23.2
4	214	17.2
<u>Group</u>	<u>2844</u>	<u>24.5</u>

6.4 Rejections due to the use of imperfect parts show the following relative standings:

TABLE 5

<u>Operator</u>	<u>No. of Rejections due to use of defective parts Operators Responsible</u>	<u>Percent of her total Rejections</u>
3	699	28.1
2	1000	36.6
1	695	24.8
5	618	22.7
4	385	11.8
<u>Group</u>	<u>2497</u>	<u>26.5</u>

7. Because of the difference in the number of hours worked mornings and afternoons, any comparison of the quality of work for these two divisions of the day must be based on average hourly defects, rather than total A.M. and total P.M. defects. Table 6 gives the average number of defects per hour for each operator and for the group, for the divisions given in Sheet 4C. The figures were found by dividing the A.M. figures in Sheet 4C by 915.75, the number of A.M. hours worked during the 45 weeks; and by dividing the P.M. figures in Sheet 4C by 617.33, the number of P.M. hours worked during the 45 weeks.

TABLE 6

Opers.	Operators Responsible				Opers. Resp. Total	Opers. Not Respons.	Total
	Assembly			Parts			
	Screwdriver	Incorrect Assembly	Total				
<u>A.M.</u>							
1	.105	.307	.202	.464	.908	.232	1.232
2	.207	.416	.678	.666	1.300	.414	1.774
3	.127	.305	.402	.485	.800	.204	1.19
4	.100	.121	.217	.244	.361	.21	.700
5	.121	.205	.200	.422	.612	.275	1.000
Total	.660	1.314	2.300	2.222	4.800	1.435	6.000
<u>P.M.</u>							
1	.100	.214	.7	.456	1.136	.25	1.301
2	.200	.400	.700	.600	1.401	.204	1.602
3	.107	.400	.200	.371	.664	.317	1.200
4	.100	.100	.201	.200	.412	.212	.60
5	.100	.200	.200	.400	.600	.200	1.200
Total	1.000	1.915	2.001	2.107	5.100	1.415	6.00

Table 6 reveals a definite tendency for rejections due to defective assembly processes to increase in the afternoon. However the

rejections due to failure to detect and discard defective parts (see both the fourth and sixth columns) show no real difference. The figures for each operator are consistent with the group totals, indicating that attention to work processes decreases during the day, but that visual observation remains the same.

8. The following tables indicate the relative importance of the five kinds of defects which caused 73% of all relay rejections. Table 7 shows the share of each operator in the group total:

TABLE 7

	Operators					Group
	1	2	3	4	5	
Springs Damaged	18.2	28.4	22.3	15.2	17.9	100.0
Contacts Wrong or Missing	17.9	25.2	22.0	10.8	24.1	100.0
Screws Buried or Stripped	18.9	31.5	14.2	20.3	12.6	100.0
Insulators Broken	20.4	40.0	12.8	10.6	16.2	100.0
Insulators Missing	28.0	25.8	16.7	7.3	24.4	100.0
Production	20.4	22.4	19.2	19.5	18.5	100.0

Table 8 shows the share of each operator's rejections which was due to each of the five kinds of defects:

TABLE 8

	Operators					Group
	1	2	3	4	5	
Springs Damaged	15.0	18.6	21.7	22.5	12.3	18.9
Contacts Wrong or Missing	16.0	14.1	20.7	15.3	24.0	18.3
Screws Buried or Stripped	12.4	15.9	12.0	25.3	9.9	14.5
Insulators Broken	12.2	17.0	8.0	10.1	10.8	12.2
Insulators Missing	10.9	6.6	6.8	4.5	19.6	8.0
Other Defects	22.5	25.2	20.2	24.5	24.4	28.1
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

9. These tables show that the individuals have the greatest trouble with the following defects:

<u>Oper.</u>	<u>Defect</u>	<u>% of Group Rejections for this cause</u>	<u>% of her own Rejections for any cause</u>
1	Insulators Missing	28.0	10.8
2	(Screws Buried or Stripped	31.5	15.9
	(Insulators Broken	40.0	17.0
3	(Springs Damaged	22.5	21.7
	(Contact Wrong or Missing	22.0	20.7
4	(Springs Damaged	15.2	22.5
	(Screws Buried or Stripped	20.8	25.5
5	(Contacts Wrong or Missing	24.1	24.0
	(Insulators Missing	24.4	10.6

- 9.1 Operator 1 has an exorbitant share of only the "Insulators Missing" rejections. This defect is due to absent-mindedness in assembly processes. Sheet 4D shows that 33.3% of this girl's defects are due to incorrect assembly, while the group as a whole has 28.0% of its defects from this cause. In other types of defects this operator is always near or below the group average.

- 9.2 Operator 2 leads the group in every sort of defect, but she is most out of line in rejections due to failure to watch for defective insulators, and to hasty and careless use of the screw-driver.

- 9.3 The defect known as "Springs Damaged" is regarded as one for which operators are not fully responsible, yet this defect may be cut down by careful observation of springs. Wrong or Missing

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