METHOD FOR TESTING "HOLMES HYPOTHESIS" FOR U.D.

1. The Holmes hypothesis I take as implying the following: -

   (i) that U.D. is made up of two components – a fixed plugwheel and a rotatable umkehrwalze

   (ii) that there is a fixed pairing, BO and two types of other pairings. An example of the first type (normal) would be from A on right hand side of the plugwheel to J on the left hand side, J paired to U through the umkehrwalze and U paired to K back through the plugwheel, giving an AK pairing through the complete U.D. An example of the second type (circumference strip) would be from E on right hand side of the plugwheel to Q on the left hand side, Q paired to B and thence via O to S (see Holmes's) diagram) through umkehrwalze and S paired to L back through the wheel, giving an EL pairing through the complete U.D.

2. Now suppose amongst the various wirings of U.D. (9 at present) we have two corresponding to positions 13 apart of the rotatable component (Babbage pointed out to me how alphabets 13 apart would give the quickest way of finding the wiring of a normal type new wheel, given sufficient alphabets, which suggested that a similar attack in this case might be feasible). (I) Suppose AC is a normal pairing at the first of these positions, and HQ a pairing at the second position. Then, if A is thirteen ahead of H on the upright of the red square, it follows that c must be thirteen ahead of Q. For suppose A is wired through the plugwheel to J and that J and R are paired through the rotatable component and R wired back to C, giving AC. Then, when rotatable section has gone round 13 places, the JR connection will have become WE: when the current goes in at H it comes through plugwheel to W (since A is 13 ahead of H on rod square upright) and therefore will come back to E and then through plugwheel to Q (HQ being paired), therefore C must be 13 ahead of Q. We can write this AH_{13}™CQ_{13}. (ii) Suppose Ac is a circumference strip pairing. Then it is still true that AH_{13}™CQ_{13} if HQ is a pairing at the wnd position. For suppose A comes through the plugwheel to JO and J and B are connected, and also O and R connected, and R wired back to C, giving AC. Then when rotatable section has gone round 13 places we get, instead of J – B – O – R, W – O – B – E. From H we go through plugwheel to W, then via O and B to E and back to Q through plugwheel, therefore again AH_{13}™$CQ_{13.}$

3. We are now in a position to examine any pair of alphabets to see whether or not they can be 13 apart. Take D_1 and D_2 for example.

   D_1 = AL, CM, DG, EZ, FR, HY, IX, JN, KU, PW, QT, SV, BO.
   D_2 = AK, CR, DN, EV, FS, GW, HP, IZ, JU, LX, MQ, TY, BO.

Assume AC_{13}, say. Then AC_{13} ™ LR_{13} ™ (via CA and RL) MK_{13} and FX_{13} ™ UQ_{13} and IS_{13} ™TJ_{13} and VZ_{13} ™ NY_{13} and $\underline{EE}_{13}$. Impossible. (It is fairly obvious that the hypothesis AR_{13} ™ LC_{13} can be simultaneously failed). In this way it can be shown that D_1 and D_2 cannot be 13 apart.

If we try D_1 and D_3 we get a more interesting result.

D_1 = AL, CM, DG, EZ, FR, HY, IX, JN, KU, PW, QT, SV, BO.
D_3 = AJ, CK, DZ, EQ, FM, GT, HU, IW, LN, PX, RS, VY, BO.

CV_{13} ™ MY_{13} ™ SK_{13} and HF_{13} ™ UR_{13} and RU_{13} } Unique solutions.
DQ_{13} ™ GE_{13} ™ TZ_{13} and ZT_{13} }

and AI_{13} ™ IN_{13} ™ XJ_{13} and PN_{13} ™ JX_{13} and NP_{13} with three alternative results AP_{13}, IX $_{13}$, WJ_{13}, IN_{13} OR AW_{13}, LI_{13}, XN_{13}, PJ13, or AX_{13}, LP_{13}, LP_{13}, WN_{13}, IJ_{13}.

4. If we assume that these alphabets, D_1 and D_3, are 13 apart it is easy to show that no other pair of alphabets from D_1 to D_9 are also 13 apart. For we have the following "13 apart" pairings:- CV, MY, SK, MF, UR, DQ, GE, TZ and 4 sets of alternatives for the remaining pairs. Now consider D_2: it has a pairing CR and since the letters "13 ahead" of C and R are V and U any alphabet 13 ahead of D_2 must have a pair UV. No alphabet has a pairing UV, therefore none of the other alphabets are separated by 13 from D_2.

5. To discover all pairs of alphabets that could be thirteen apart it is not necessary to go through the rather laborious process of trial and error described above. Suppose we wish to test D_1 and D_2. Box the alphabets and we get

(ALXIZEVSFRCMQTYHPWGDNJUK)
12468-864213579 9753

Now in the example we took AC_{13} – LR_{13} – NK_{13} and FX_{13} ™ UQ_{13} and IS_{13}, etc. and it can be seen that starting from an AC we are moving though the box as shown by the small figures. If we have only one box compartment of a given size between 2 alphabets it is fairly easy to see that we get a solution if and only if it has 4n-2 letters in it. Within the box one alphabet is represented by letters 1 and 2, 3 and 4, 5 and 6, etc. and the other alphabet by letters 2 and 3, 4 and 5, 6 and 7, etc. Now make an assumption (e.g. AC in the example above) involving two letters separated by an odd number of letters i.e. pairing the 1^{st} letter with the $(2n – 1)^{th}$. Then 1^{st} and 3^{rd} letters belong to one alphabet and the 2^{nth} and $(2n-1)^{th}$ to the other. Therefore starting from such an assumption we shall work <u>in opposite directions</u> from the basic letters and, since there are an odd number of letters between, the basic letters must reach a contradiction through a letter being paired with itself. Secondly make an assumption – e.g. "AE" in (ALXIZEVSFRCMQTYHPWGDNJUK)
1248531246 53

with two letters separated by an even number of letters, i.e. 1^{st} letter paired with the 2^{nth}. Then we work <u>in the same direction</u> from the basic letters (see example) and are bound to get a contradiction unless the 1^{st} and 2nth have equal intervals between them in either direction, i.e. unless there are 4n – 2 letters altogether. On the other hand if there are 4n – 2 letters we shall always get such a solution. Finally, if there are two compartments of the same size in a box between two alphabets we can always get a solution by pairing off the two compartments in any way, i.e. any letter in one compartment can go with a given letter in the other and once this original choice is made all the other pairings follow.

6. The nine alphabets so far recovered box in the following ways amongst themselves:- 12 24's, 6 22's, 5 16-8, 2 20-2-2, 2 12-12, 2 12-8-4, 2 12-8-4, 2 12-8-2-2, 1 each of 20-4, 18-6,, 10-6-6-2, 10-6-4-4. Of these the only possibles are 6 22-2's, 2 12-12's, 18-6, 10-5-5-2, 10-5-4-4. The 22-2's and the 18-6 give unique solutions, the 12-12's give 12 each and the 10-6-6-2 and 10-6-4-4 give respectively 6 and 8 pairings uniquely and 7 and 4 solutions respectively for the remaining pairings. So we have in all 33 substantially different solutions. No two of these 33 solutions are compatible with each other (see Appendix), therefore there is at most one pair of alphabets 13 apart in the first nine.

7. Now suppose (a) that the rotatable section of the umkehrwalze has a wiring joining two points 13 apart. Then if there are two of the D's 13 apart they will either have a common pairing (i.e. be female to each other) or else the two points must happen to come at B and O for these two particular D's. In the former case all or all but one of the rest of the D's (this one being an alphabet for which the wiring joins points opposite B and O on the rotatable section – there cannot be two such or we should have another pair of alphabets 13 apart, already disproved) must have a pair in common with the set of 13 aheads which we are testing. In the latter case all without exception must have a pair in common with the set of 13 aheads and in either case all these pairs must be distinct from each other. Consideration of what the 13 aheads are will make it obvious that this must be true.

8. Suppose (b) that the rotatable component has no wiring joining two points 13 apart. Then we can only get a "13 ahead" pairing concurring if we have 2 pairings of the rotatable section each joining two points the same distance apart and also the 2 pairings themselves being 13 apart, e.g. on the rotatable component, i.e. on the left of the plugwheel, a joined to d and n to q. If this happens then the circumference strip pairing will give a "13 ahead" pairing for four positions of the rotatable component e.g. in the case instanced (ad and nq) we shall get (1) b e and o r (2) y b and l o (3) o r and b e (4) l o and y b and these positions will fall into pairs 13 apart, each pair being "female" on a 13 ahead pairing. Moreover, if two pairings of this kind exist, any pair of alphabets 13 apart, for which the two pairings do not involve B or O, will be doubly female. In my example of a d and n q are joined, then, when the rotatable component moves round 13 places, we get n q and a d joined, i.e. the same pairs over again.

9. To sum up the position, suppose we are testing a set of 13 aheads, derived from 2 D alphabets. Then either (1) these alphabets are not female. In that case (a) from (b) above no 13 ahead pairing must occur as a pair in any individual D alphabet or else (b) from c

above) every alphabet except the 2 basic ones must contain one and only one of the “13 aheads”, and each alphabet must contain a different one. (2) The alphabets are singly female. In that case every other alphabet, except possibly one, must contain one and only one of the “13 aheads”, (or else – just possibly – all but one contain exactly two of the “13 aheads”, and that one contains one) and these “13 aheads” must again be all different. (3) The alphabets are doubly female. In that case (a) one or two (not more) of the remaining alphabets may contain a pairing of the “13 aheads” or (b) every other alphabet except possibly one or two (not more) must contain exactly two of the “13 aheads”, and this one or two must contain one.

10. These conditions are extremely stringent ones and none of the possible solutions in Para 6 satisfy it, so if the Holmes hypothesis is

11. correct no two of the nine D’s recovered can be 13 apart. Assuming the 9 to be randomly chosen the chance of this a priori is

$$\frac{24.22.20.18.16.14.12.10}{25.24.23.22.21.20.19.18} = \frac{1}{8.5}$$

(approx), so that a factor of 8.5 has been put against the hypothesis.

C.H.O’D Alexander.

14th April, 1944

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APPENDIX I

Although in this particular case there was no hypothesis left for further testing it might have happened that we should have found a set of 13 aheads which would satisfy the conditions in Para 9 and it is interesting to consider how we could test it further.

First we will consider how we could deal with the problem if there were no circumference strip pairing, and second how we can reduce the actual case to this.

(a) All pairings normal. Consider any two alphabets, say AS, CM, DG, EZ, FR, HY, IX, JN, KU, PW, QT, LV and AK, CR, DN, EV, FS, GW, HP, IZ, JU, LX, NQ, TY and a set of "13 aheads", say AC, LG, TP, EN, QK, XY, JI, MU, ZH, RN, DF, SV. Suppose these alphabets are distance K apart. Then suppose AR to be a "K ahead": then, AS being a pairing in the 1st alphabet, and CR in the 2nd, SC will also be a "k ahead". But since AC and RN are "13 aheads", then, if AR is a "k ahead", CN must also be a "k ahead": similarly SC ™ VA. From CN and VA we now deduce MD and LK from the original pair of alphabets and so on. This process can be simplified by boxing each alphabet in turn with the set of "13 aheads". This gives us

(ASVLGDFRNJIXYHZEWPTQKUNC) and (AKQMJIZHPTYXLGWEVSFDNRC)
1246 53 46 5312

and the numbering shows clearly how the pairings go (if we assume AC we go through the 2nd box in reverse order). Unless these two boxes are the same size as each other we shall obviously get a contradiction wherever we start, since we shall get back to the start of one box before we get back to the start of the other. In this case the hypothesis that the set of "13 aheads" is genuine is immediately destroyed. If the boxes are the same size (as here) then we have the following very powerful test: take the case Ag_k. Ag_k ™SWI_k and so the boxes pair off like this:

ASVLGDFRNJIXYMZEWPTQKUMC (1)
GWEVSFDNRCAKQMUJIZHPTYXL (2)

Therefore (boxing these) Ag_k, GS_k, SW_k, WI_k, IA_k, therefore 5k – 26 since 5 moves down the upright of k each bring us back to the start. This is impossible. Therefore position is failed. The only possibilities are as follows:- (1) k odd. Starting from A we reach C in <u>13</u> turns and get back to A in 26. (2) k even. We reach A in 13 turns and C is in the other compartment ("AC" is a 13 ahead pair). This implies incidentally of course that when (1) and (2) are correctly set against each other they must give a 26 box or two 13 boxes and we can see at once that the position shown is wrong, since we have two 2 boxes (RN) and (DF) which would only be possible if the alphabets were 13 apart, which is already known to be untrue.

Normally we shall get no possible solution (there is none in this case) and then the sets of 13 aheads would be failed. If we do get a possible solution, then there will only be 13 possible values of K (odd or even according to the type of solution) each giving a complete upright from which the rod square can be reconstructed and the other alphabets compared with it which would be immediately decisive.

So when all pairings are normal we can fail a given “13 ahead” set fairly easily with two alphabets.

Now consider the actual case. A “Holmes alphabet” differs from a normal one got by having B wired through the plugwheel to B and O to O (or B to O and O to B) only in replacing pairs BJ and OK (say) by BO and JK, therefore to reduce a Holmes alphabet to an ordinary one interchange O with any of the other 24 letters, i.e. there are 24 possible “solutions”. In the most difficult case (where none of the alphabets are female with the “13 ahead” set) box all of them with the 13 ahead set alphabet. Choose the two boxes most unlike in shape. Now, since as shown above, the boxes for normal alphabets must be the same shape, if the set of “13 aheads” is right, the interchange of O with another letter must be made in such a way in the two alphabets as to produce boxes with the same shapes. Make the 24 interchanges for each of the two alphabets: these will obviously be very few if any pairs of alphabets with the same shape and they can be failed as described above. If one or more of the alphabets are female with the 13 ahead set the problem may be simplified owing to the circumferences strip pairing being identified (see Para I) and thus the letter to be interchanged with O being one of two.

Since writing the foregoing paragraph, I have seen that the problem is a great deal simpler than I thought. The only effect of changing, Say, AL and BO into AO we have A to O, O to B (from BO in the 13 aheads), B to L, therefore unless the box shapes of the original Holmes alphabets with the 13 aheads are the same or differ only in such a way that they can be made the same by adding 2 to one compartment of each (e.g. a 10/6 and an 8/8 can both be turned into 10/8) it is impossible for the corresponding “normal” alphabets to have the same box shape. So, except in the most unlikely event of all the alphabets producing the same or very closely similar box shapes when boxed with the set of “13 aheads”, the hypothesis that the set is genuine can be failed at sight.

APPENDIX II

D ALPHABETS BOXED TOGETHER

Alphabets	1	2	3	4	5	6	7	8	9
	AL	AK	AJ	AL	AF	AY	AF	AV	AB
	CM	CR	CK	CD	CG	CK	CJ	CP	CI
	DG	DN	DZ	ET	DR	DF	DI	DW	DY
	EZ	EV	EQ	FN	EQ	ES	EP	ER	FK
	FR	FS	FM	GP	HN	GR	GQ	FN	GX
	HY	GW	GT	HU	IU	HZ	HS	GM	HJ
	IX	HP	HU	IY	JX	IW	KV	HX	LV
	JN	IZ	IW	JM	KY	JU	LY	IT	MT
	KU	JU	IN	KW	LT	LV	MT	JS	NS
	PW	LX	PX	QX	MZ	MQ	NW	KZ	PR
	QT	MQ	RS	RZ	PW	NX	RX	LU	QU
	SV	TY	VY	SV	SV	PT	UZ	QY	WZ
	BO	BO	BO	BO	BO	BO	BO	BO	BO

		Box shape	Number
12	(ALXIZEVSFRCMQTYHPWGDNJUK)	24	12
23	(AKCRSFMQEVYTGWIZDNLXPHUJ)	22/22	6
34	(AJMFNL)(EQXPGT)(CKWIYVSRZD)(HU)	20/2/2	2
45	(ALTEQXJMZRDCGPWKYIUHNF)(SV)	20/4	1
56	AFDRGCKY)(EQMZHNXJUIWPTLVS)	18/6	1
67	(AYLVKCJUZHSEPTMQGRXNWIDF)	16/8	5
78	(AFNWDITMGQYLUZKV)(CJSHXREP)	12/12	2
89	(AVLUQYDWZKFNSJHXGMTICPRE)	12/8/4	2
91	(AEZWPRFKUQTECIXGDYHJNSVL)	12/8/2/2	2
13	(ALNJ)(IXPW)(DGTQEZ)(CMFRSVYHUK)	12/6/6	1
24	(AKWGPHUJMQXL)(CRZIYTEVSFND)	10/6/6/2	1
35	(AJXPWIUHNLTGCKYVSRDZMF)(EQ)	10/6/4/4	1
46	(ALVSETPGRZHUJMQXNFDCKWIY)		
57	(CGQEPWNHSVKYLTMZUIDRXJ)(AF)		
68	(AYQMGRESJULV)(CKZHXNFDWITP)		
79	(AFKVLYDICJHSNWZUQGXRPE)(MT)		
81	(CMGDWP)(HYQTIX)(AVSJNFREZKUL)		
92	(AKFSNDYTMQUJHPRCIZWGXLVE)		
14	(CMJNFRZETQXIYHUKWPGD)(SV)(AL)		
25	(AKYTLXJUIZMQEVSF)(CRDNHPWG)		
36	(AJUHZDFMQESRGTPXNLVY)(CK)(IW)		
47	ALYIDCJMTEPGQXRZUHSVK NF)		
58	(AFNHXJSV)(IULT)(CGMZKYQERDWP)		
69	(AYDFKCIWZHJUQMTPRGXNSE)(LV)		
71	(ALYHSVKUZEPWNJCMTQGDIXRF)		
82	(AKZITYQMGWDNFSJULXHPCREV)		
93	(AJHUQE)(CKFMTGXPRSNLVYDZWI)		
15	(ALTQEZMCGDRF)(HYKUIXJN)(PW)(SV)		
26	(AKCRGWIZHPTY)(DNXLVESF)(JU)(MQ)		
37	(AJCKVYLNWIDZUHSRXPEQGTMF)		
48	(ALUHXQYITERZKWDCPGMJSV)(FN)		
59	(AFKYDRPWZMTLVSNHJXGCIUQE)		
61	ALVSEZHY)(CMQTPWIXNJUK)(DGRF)		
72	(AKVEPHSF)(CRXLYJMQGWNDIZUJ)		
83	(AJSREQYV)(CKZDWITGMFNLUHXP)		
94	(ALVSNFKWZRPGXQUHJMTE)(CDYI)		

<u>POSSIBLE SETS OF U.D. “13 APART” PAIRINGS</u>

Alphabets		
3,4.	1.	CV,KS,WR,IZ,YD,HU and AF,JN,ML,EP,QG,XT <u>or</u> (AJMFNL) with (EQXPGT)
4,5.	2.	AC,LG,TP,EW,QK,XY,JI,MU,ZH,RN,DF,SV
1,3.	3.	CV,MY,FH,RU,SK,DQ,GE,TZ and(ALNJ) with IXPW).
2,4.	4.	AC,KD,WN,GF,PS,HV,EU,JT,MY,IQ,XZ,LR.
	5.	AZ,KR,WC,GD,HN,HF,US,JV,ME,QT,XY,LI.
	6.	AY,KI,WZ,GR,PC,HD,UN,JF,MS,QV,XE,LT.
	7.	AE,KT,WY,GI,PZ,HR,UC,JD,MN,QF,XS,LV.
	8.	AS,KV,WE,GT,PY,HI,UZ,JR,MC,QD,XN,LF.
	9.	AN,KF,WS,GV,PE,HT,UY,JI,MZ,QR,XC,LD.
	10.	AD,KC,WR,GZ,PI,HY,UT,JE,MV,QS,XF,LN.
	11.	AF,KN,WD,GC,PR,HZ,UI,JY,MT,QE,XV,LS.
	12.	AV,KS,WF,GN,PD,HC,UR,JZ,MI,QY,XT,LE.
	13.	AT,KE,WV,GS,PF,HN,UD,JC,MR,QZ,XI,LY.
	14.	AI,KY,WT,GE,PV,HS,UF,JN,MD,QC,XR,LZ.
	15.	AR,KZ,WI,GY,PT,HE,UV,JS,MF,QN,XD,LC.
3,5.	16.	AG,JC,XK,PY,WV,IS,UR,HD,NZ,LM,TF,EQ.
5,7.	17.	AF,CY,GL,QT,EM,PZ,WU,NI,HD,SR,VX,KJ.
6,8.	18.	AP,YC,QK,MZ,GH,RX,EN,SF,JD,UW,LI,VT.
	19.	AI,YT,QP,MC,GK,RZ,EH,SX,JN,UF,LD,VW.
	20.	AD,YW,QI,MT,GP,RC,EK,SZ,JH,UX,IN,VF.
	21.	AN,YF,QD,MV,GI,RT,EP,SC,JK,UZ,LH,VX.
	22.	AH,YX,QN,MF,GD,RW,EI,ST,JP,UC,LK,VZ.
	23.	AK,YZ,QH,MX,GN,RF,ED,SW,JI,UT,LP,VC.
	24.	AC,PY,QT,MI,GW,RD,EF,SN,JX,UH,LZ,VK.
	25.	AZ,YK,QC,MP,GT,RI,EW,SD,JF,UN,LX,VH.
	26.	AX,YH,MK,GC,RP,ET,SI,JW,UD,LF,VN,QZ.
	27.	AF,YN,QX,MH,GZ,RK,EC,SP,JT,UI,LW,VD.
	28	AW,YD,QF,MN,GX,RH,EZ,SK,JC,UP,LT,VI.
	29.	AT,YI,QW,MD,GF,RN,EX,SH,JX,UK,LC,VP.
7,9	30.	AS,FN,KW,VZ,LU,YQ,DG,IX,CR,JP,HE,MT.
6,9.	31.	AU,YQ,DM,FT,KP,CR,IG,WX,ZN,HS,JE,LV.
9,3.	32.	AU,JQ,HE,CS,KN,FL,MV,TY,GD,XZ,PW,RI.
4,8.	33.	AZ,LK,UW,HD,XC,QP,YG,IM,TJ,ES,RV,FN.

<u>PAIRINGS IN COMMON BETWEEN D ALPHABETS AND “13 AHEAD” SETS.</u>

1. IZ 2. DY 9. HU 3,4.
2. PT 6. HZ 6. DF 6. SV 1,4,5
3. -. In subsidiary LX 2. JX 5. NX 6. NW 7. (Subs are AI,, LW, XJ, PN/AP, LX, WJ, IN/AW, LI, XN, PJ/AX, LP/WN/IJ
4. NW 7.
5. DG 1. QT 1.
6. AY 6. WZ 9. GR 6. CP 8. LT 5.
7 AE 9. LV 6,9.
8. KV 7. GT 3. UZ 7. CM 1. NX 6.
9. FK 9. EP 7. MZ 5.
10. CK 3,6. HY 1. LN 3.
11. AF 5,7. DW 8. CG 5. PR 9. HZ 6. IU5 MT 7,9. EQ 3,5.
12. AV 8. QY 8.
13. HN 5. CJ 7. IX 1. LY 7.
14. KY 5. HS 7. JN 1 RX 7.
15. KZ 8. IW 3,6. PT 6. JS 8. FM 3.
16. CJ 7. EQ 3,5.
17. AF 5,7. QT 1. RS 3
18. MZ 5. RX 7. FS 2.
19. TY 2. CM 1. RZ 4. JN 1.
20. MJ 7,9. GP 4. CR 2. HJ 9. IN 3.
21. EP 7. UZ 7.
22. FM 3. DG 1.
23. AK 2. FR 1.
24 QT 1. GW 2. DR 5. NS 9. JX 5. HU 3,4. KV 7.
25. KY 5. GT 3. LX 2.
26. HY 1. CG 5. PR 9. ET 4.
27. AF 5,7. QX 4. IU 5.
28. DY 9. GX 9. EZ1 CJ 7. LT 5.
29. IY 4. HS 7. KU 1.
30. FN 4,8. KW 4. LU 8. QY 8. DG 1. IX 1. CR 2. MT 7,9.
31. QY 8. CR 2. HS 7. LV 6,9.
32 TY 2. DG 1. PW 1,5.
33. ES 6. FN 4,8.

<u>Variations of 1.</u>

1.1.	AF, JN, ML, EP, QG, XT	AF 5,7. JN 1. EP 7. GQ 7)	
1.2.	AE, JT, MG, FP, NX, LQ	AE9. GM 8. NX 6.)	
1.3.	AQ, JX, MP, FG, NT, LE	JX 5.)	
1.4.	AX, JQ, ME, FT, NG, LP.	)	All down
1.5.	AP, JG, MT, FE, NQ, LX.	MT 7, 9. LX 2.)	
1.6.	HG, JP, MX, FQ, NE, LT.	LT 5.)	
1.7.	AT, JE, MQ, FX, NP, LG.	MQ 2,6)	

All 33 positions failed. None of the female pairings satisfy the conditions of Para 8-10.

<u>Further note on Holmes Hypothesis.</u>

1. The Holmes alphabet differs from a normal alphabet only in having the pairings BJ, OX (say) replaced by BO, JX , and could be reduced to a normal alphabet by exchanging B or O with one of the 24 other letters, which letter is correct being unknown. (See Appendix 1 to the original paper on Holmes hypothesis; the normal alphabet in question would be one arising from a wheel with cross-wirings B to O and O to B instead of a fixed BO pairing). This paper deals with the modifications such an alteration produces in box shapes and some deductions that can be made from that.

2. Box together two Holmes alphabets, e.g. D1 and D2* which give

(ALXIZEVS FRCMQTYHP WGDNJUK) (BO)

Imagine that the change needed to reduce these to normal alphabets is to replace PW and BO by PO and BW in D1 and FS and BO by FO and BS. This splits the original box at the places shown by the dotted lines and we get

ALXIZEVSB-OFRCMQTYHPO-BWGDNJUKA

which joins up as (BWGDNJUKALXIZEVS) and (OFRCMQTYHP). If instead of FO and BS we had taken FB and OS we should have got

ALXIZEVSO-BFRCMQTYHPO-BWGDNJUKA which rejoins as one big box (ALXIZEVSOPHYTQMCRFBWGDNJUK).

It is easy to see also that we can “insert” the BO’s in such a way as to join together two compartments if the original box shape contained more than one compartment, e.g., (ALNJ) and (DGTQ EZ) become AB-OLNJA and DGTQO-BEZD giving

(ABEZDGTQOLNJ)

Finally if one of the Holmes alphabets has no circumference strip pairing, i.e., is a normal alphabet already the alteration in the box is simply to insert BO or OB somewhere in it.

3. The transformation from Holmes alphabets into normal alphabets can therefore only alter the box shapes in one of three ways. (1) Enlarge one of the original compartments by 2. (2) Split a compartment of size 2 into any two compartments of size 2a and 2b such that a+b=n+1. We can only have a or b=1 by leaving the original alphabet unaltered. (3) Join any two compartments of sizes 2a and 2b into a single compartment of size 2 (a+b+1). In no case can the number of compartments (excluding BO) in the box formed by the Holmes compartments be increased or decreased by more than one.

4. It follows at once that the D’s have not been equally spaced out. For D1, D2 boxes as a 24 and D3D4 as 10-6-6-2, and these cannot be made the same by transforming the Holmes alphabets into normal alphabets. ∴ the distance between D1 and D2 is different from the distance between D3 and D4.

5. To apply an exhaustive test of the Holmes Hypothesis would now be theoretically possible, but far too laborious to be a practical proposition. The method would be to consider all the possible box shapes that could arise from

modifying the Holmes alphabets and test pairs of those that agreed on the theory that they corresponded to a repeated distance. This is the analogous method to that used for testing after adding up in the normal use of a fixed umkehrwalze and movable fourth wheel.

6. A list of possible box shapes got by modifying the Holmes alphabets is appended.

* D1 = AL,CM,DG,EZ,FR,HY,IX,JN,KU,PW,QT,SV,BO.
D2 = AK, CR,DN,EV,FS,GW,HP,IZ,JU,LX,MQ,TY,BO.

List of possible box shapes got by modifying Holmes alphabets.

Actual Box Shape	Possible Box Shapes from Modified Alphabets.
24	26. 26-α/α
22/2	26. 24/2 24-α/α/2.
20/2/2	24/2 20/6 22/2/2. 20/4/2. 22-α/α/2/2
20/4	26. 22/4 20/6 22-α/α/4. 20/b-α/α
18/6	26. 20/6. 18/8. 20-α/α/6 18/8-α/α
16/8	26 18/8. 16/10. 18-α/α/8. 16/10-α/α.
12/12	26. 14/12. 14-α/α/12.
12/8/4	22/4. 18/8. 14/12. 14-α/α/8/4 12/10-α/α/4. 12/8/6-α/α
12/6/6	20/6. 14/12 14-α/α/6/6. 12/8-α/α/6.
10/6/6/2.	18/6/2. 14/6/6. 14/10/2. 10/10/6. 12/6/6/2. 10/8/6/2. 10/6/6/4 12-α/α/6/6/2. 10/8-α/α/6/2.
10/6/4/4.	18/4/4. 16/6/4. 12/10/4. 10/10/6. 12/6/4/4. 10/8/4/4 10/6/6/4 12-α/α/6/4/4 10/8-α/α/4/4 10-6/6-α/α/4