C. FARQUHAR.

TABLE FOR CODING, DECODING, AND CHECKING COMMUNICATIONS.

APPLICATION FILED OCT. 14, 1916.

**1,318,366.**

Patented Oct. 14, 1919.

8 SHEETS—SHEET 1.

**FIG. I.**

| | | | | | |
|---|---|---|---|---|---|
| aa–0495 | ca–0287 | ea–0079 | ga–0371 | ia–0264 | ka–0157 |
| ab–0087 | cb–0478 | eb–0171 | gb–0064 | ib–0656 | kb–0549 |
| ac–0278 | cc–0670 | ec–0563 | gc–0456 | ic–0349 | kc–0242 |
| ad–0470 | cd–0363 | ed–0256 | gd–0149 | id–0042 | kd–0634 |
| ae–0163 | ce–0056 | ee–0648 | ge–0541 | ie–0434 | ke–0327 |
| af–0555 | cf–0448 | ef–0341 | gf–0234 | if–0127 | kf–0020 |
| ag–0248 | cg–0141 | eg–0034 | gg–0626 | ig–0519 | kg–0412 |
| ah–0640 | ch–0533 | eh–0426 | gh–0319 | ih–0212 | kh–0105 |
| ai–0333 | ci–0226 | ei–0119 | gi–0012 | ii–0604 | ki–0297 |
| aj–0026 | cj–0618 | ej–0511 | gj–0404 | ij–0097 | kj–0488 |
| ak–0418 | ck–0311 | ek–0204 | gk–0496 | ik–0288 | kk–0080 |
| al–0111 | cl–0004 | el–0296 | gl–0088 | il–0479 | kl–0072 |
| am–0503 | cm–0096 | em–0487 | gm–0279 | im–0571 | km–0464 |
| an–0291 | cn–0083 | en–0674 | gn–0567 | in–0460 | kn–0353 |
| ao–0482 | co–0474 | eo–0367 | go–0260 | io–0153 | ko–0046 |
| ap–0274 | cp–0167 | ep–0060 | gp–0652 | ip–0545 | kp–0438 |
| aq–0666 | cq–0559 | eq–0452 | gq–0345 | iq–0238 | kq–0131 |
| ar–0359 | cr–0252 | er–0145 | gr–0038 | ir–0630 | kr–0523 |
| as–0052 | cs–0644 | es–0537 | gs–0430 | is–0323 | ks–0216 |
| at–0444 | ct–0337 | et–0230 | gt–0123 | it–0016 | kt–0608 |
| au–0137 | cu–0030 | eu–0622 | gu–0515 | iu–0408 | ku–0301 |
| av–0529 | cv–0422 | ev–0315 | gv–0208 | iv–0101 | kv–0093 |
| aw–0222 | cw–0115 | ew–0008 | gw–0600 | iw–0492 | kw–0284 |
| ax–0614 | cx–0507 | ex–0400 | gx–0292 | ix–0084 | kx–0575 |
| ay–0307 | cy–0200 | ey–0092 | gy–0483 | iy–0375 | ky–0268 |
| az–0000 | cz–0491 | ez–0283 | gz–0175 | iz–0068 | kz–0660 |
| ba–0391 | da–0183 | fa–0075 | ha–0667 | ja–0560 | la–0453 |
| bb–0582 | db–0574 | fb–0467 | hb–0360 | jb–0253 | lb–0146 |
| bc–0374 | dc–0267 | fc–0160 | hc–0053 | jc–0645 | lc–0538 |
| bd–0067 | dd–0659 | fd–0552 | hd–0445 | jd–0338 | ld–0231 |
| be–0459 | de–0352 | fe–0245 | he–0138 | je–0031 | le–0623 |
| bf–0152 | df–0045 | ff–0637 | hf–0530 | jf–0423 | lf–0316 |
| bg–0544 | dg–0437 | fg–0330 | hg–0223 | jg–0116 | lg–0009 |
| bh–0237 | dh–0130 | fh–0023 | hh–0615 | jh–0508 | lh–0401 |
| bi–0629 | di–0522 | fi–0415 | hi–0308 | ji–0201 | li–0193 |
| bj–0322 | dj–0215 | fj–0108 | hj–0001 | jj–0592 | lj–0384 |
| bk–0015 | dk–0607 | fk–0500 | hk–0392 | jk–0184 | lk–0675 |
| bl–0407 | dl–0300 | fl–0192 | hl–0583 | jl–0475 | ll–0368 |
| bm–0100 | dm–0591 | fm–0383 | hm–0275 | jm–0168 | lm–0061 |
| bn–0187 | dn–0578 | fn–0271 | hn–0164 | jn–0057 | ln–0649 |
| bo–0378 | do–0071 | fo–0663 | ho–0556 | jo–0449 | lo–0342 |
| bp–0570 | dp–0463 | fp–0356 | hp–0249 | jp–0142 | lp–0035 |
| bq–0263 | dq–0156 | fq–0049 | hq–0641 | jq–0534 | lq–0427 |
| br–0655 | dr–0548 | fr–0441 | hr–0334 | jr–0227 | lr–0120 |
| bs–0348 | ds–0241 | fs–0134 | hs–0027 | js–0619 | ls–0512 |
| bt–0041 | dt–0633 | ft–0526 | ht–0419 | jt–0312 | lt–0205 |
| bu–0433 | du–0326 | fu–0219 | hu–0112 | ju–0005 | lu–0397 |
| bv–0126 | dv–0019 | fv–0611 | hv–0504 | jv–0197 | lv–0588 |
| bw–0518 | dw–0411 | fw–0304 | hw–0596 | jw–0388 | lw–0180 |
| bx–0211 | dx–0104 | fx–0396 | hx–0188 | jx–0579 | lx–0172 |
| by–0603 | dy–0196 | fy–0587 | hy–0379 | jy–0671 | ly–0564 |
| bz–0595 | dz–0387 | fz–0179 | hz–0471 | jz–0364 | lz–0257 |

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8 SHEETS—SHEET 2.

FIG. 2.

| | | | | | | |
|---|---|---|---|---|---|---|
| ma–0050 | oa–0642 | qa–0535 | sa–0428 | ua–0321 | wa–0214 | ya–0107 |
| mb–0442 | ob–0335 | qb–0228 | sb–0121 | ub–0014 | wb–0606 | yb–0499 |
| mc–0135 | oc–0028 | qc–0620 | sc–0513 | uc–0406 | wc–0299 | yc–0091 |
| md–0527 | od–0420 | qd–0313 | sd–0206 | ud–0099 | wd–0490 | yd–0282 |
| me–0220 | oe–0113 | qe–0006 | se–0498 | ue–0290 | we–0082 | ye–0074 |
| mf–0612 | of–0505 | qf–0298 | sf–0090 | uf–0481 | wf–0573 | yf–0466 |
| mg–0305 | og–0098 | qg–0489 | sg–0281 | ug–0373 | wg–0266 | yg–0159 |
| mh–0497 | oh–0289 | qh–0081 | sh–0173 | uh–0066 | wh–0658 | yh–0551 |
| mi–0089 | oi–0480 | qi–0672 | si–0565 | ui–0458 | wi–0351 | yi–0244 |
| mj–0280 | oj–0472 | qj–0365 | sj–0258 | uj–0151 | wj–0044 | yj–0636 |
| mk–0272 | ok–0165 | qk–0058 | sk–0650 | uk–0543 | wk–0436 | yk–0329 |
| ml–0664 | ol–0557 | ql–0450 | sl–0343 | ul–0236 | wl–0129 | yl–0022 |
| mm–0357 | om–0250 | qm–0143 | sm–0036 | um–0628 | wm–0521 | ym–0414 |
| mn–0246 | on–0139 | qn–0032 | sn–0624 | un–0517 | wn–0410 | yn–0303 |
| mo–0638 | oo–0531 | qo–0424 | so–0317 | uo–0210 | wo–0103 | yo–0295 |
| mp–0331 | op–0224 | qp–0117 | sp–0010 | up–0602 | wp–0095 | yp–0486 |
| mq–0024 | oq–0616 | qq–0509 | sq–0402 | uq–0494 | wq–0286 | yq–0078 |
| mr–0416 | or–0309 | qr–0202 | sr–0294 | ur–0086 | wr–0477 | yr–0270 |
| ms–0109 | os–0002 | qs–0094 | ss–0485 | us–0277 | ws–0070 | ys–0662 |
| mt–0501 | ot–0493 | qt–0285 | st–0077 | ut–0569 | wt–0462 | yt–0355 |
| mu–0293 | ou–0085 | qu–0476 | su–0369 | uu–0262 | wu–0155 | yu–0048 |
| mv–0484 | ov–0276 | qv–0169 | sv–0062 | uv–0654 | wv–0547 | yv–0440 |
| mw–0076 | ow–0668 | qw–0561 | sw–0454 | uw–0347 | ww–0240 | yw–0133 |
| mx–0468 | ox–0361 | qx–0254 | sx–0147 | ux–0040 | wx–0632 | yx–0525 |
| my–0161 | oy–0054 | qy–0646 | sy–0539 | uy–0432 | wy–0325 | yy–0218 |
| mz–0553 | oz–0446 | qz–0339 | sz–0232 | uz–0125 | wz–0018 | yz–0610 |
| na–0346 | pa–0239 | ra–0132 | ta–0025 | va–0617 | xa–0510 | za–0403 |
| nb–0039 | pb–0631 | rb–0524 | tb–0417 | vb–0310 | xb–0203 | zb–0395 |
| nc–0431 | pc–0324 | rc–0217 | tc–0110 | vc–0003 | xc–0195 | zc–0586 |
| nd–0124 | pd–0017 | rd–0609 | td–0502 | vd–0594 | xd–0386 | zd–0178 |
| ne–0516 | pe–0409 | re–0302 | te–0394 | ve–0186 | xe–0577 | ze–0370 |
| nf–0209 | pf–0102 | rf–0194 | tf–0585 | vf–0377 | xf–0170 | zf–0063 |
| ng–0601 | pg–0593 | rg–0385 | tg–0177 | vg–0669 | xg–0562 | zg–0455 |
| nh–0393 | ph–0185 | rh 0576 | th–0469 | vh–0362 | xh–0255 | zh–0148 |
| ni–0584 | pi–0376 | ri–0269 | ti–0162 | vi–0055 | xi–0647 | zi–0540 |
| nj–0176 | pj–0069 | rj–0661 | tj–0554 | vj–0447 | xj–0340 | zj–0233 |
| nk–0568 | pk–0461 | rk–0354 | tk–0247 | vk–0140 | xk–0033 | zk–0625 |
| nl–0261 | pl–0154 | rl–0047 | tl–0639 | vl–0532 | xl–0425 | zl–0318 |
| nm–0653 | pm–0546 | rm–0439 | tm–0332 | vm–0225 | xm–0118 | zm–0011 |
| nn–0542 | pn 0435 | rn–0328 | tn–0221 | vn–0114 | xn–0007 | zn–0599 |
| no–0235 | po–0128 | ro–0021 | to–0613 | vo–0506 | xo–0399 | zo–0191 |
| np–0627 | pp–0520 | rp–0413 | tp–0306 | vp–0199 | xp–0590 | zp–0382 |
| nq–0320 | pq–0213 | rq–0106 | tq–0598 | vq–0390 | xq–0182 | zq–0174 |
| nr–0013 | pr–0605 | rr–0398 | tr–0190 | vr–0581 | xr–0673 | zr–0566 |
| ns–0405 | ps–0198 | rs–0589 | ts–0381 | vs–0473 | xs–0366 | zs–0259 |
| nt–0597 | pt–0389 | rt 0181 | tt–0273 | vt–0166 | xt–0059 | zt–0651 |
| nu–0189 | pu–0580 | ru–0073 | tu–0665 | vu–0558 | xu–0451 | zu–0344 |
| nv–0380 | pv–0572 | rv–0465 | tv–0358 | vv–0251 | xv–0144 | zv–0037 |
| nw–0372 | pw–0265 | rw–0158 | tw–0051 | vw–0643 | xw–0536 | zw–0429 |
| nx–0065 | px–0657 | rx–0550 | tx–0443 | vx–0336 | xx–0229 | zx–0122 |
| nv–0457 | py–0350 | ry–0243 | ty–0136 | vy–0029 | xy–0621 | zy–0514 |
| nz–0150 | pz–0043 | rz–0635 | tz–0528 | vz–0421 | xz–0314 | zz–0207 |

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8 SHEETS—SHEET 3.

FIG. 3.

| COL. 1 | COL. 2 | COL. 3 | COL. 4 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lb | aa | yl | ky | 0000 | 0036 | 0072 | 0108 | 0144 | 0180 | 0216 | 0252 | 0288 | 0324 | 0360 | 0396 | 0432 | 0468 | 0504 |
| lc | ae | ym | ku | 0001 | 0037 | 0073 | 0109 | 0145 | 0181 | 0217 | 0253 | 0289 | 0325 | 0361 | 0397 | 0433 | 0469 | 0505 |
| ld | ai | yn | ko | 0002 | 0038 | 0074 | 0110 | 0146 | 0182 | 0218 | 0254 | 0290 | 0326 | 0362 | 0398 | 0434 | 0470 | 0506 |
| lf | ao | yp | ki | 0003 | 0039 | 0075 | 0111 | 0147 | 0183 | 0219 | 0255 | 0291 | 0327 | 0363 | 0399 | 0435 | 0471 | 0507 |
| lg | au | yr | ke | 0004 | 0040 | 0076 | 0112 | 0148 | 0184 | 0220 | 0256 | 0292 | 0328 | 0364 | 0400 | 0436 | 0472 | 0508 |
| lk | ay | ys | ka | 0005 | 0041 | 0077 | 0113 | 0149 | 0185 | 0221 | 0257 | 0293 | 0329 | 0365 | 0401 | 0437 | 0473 | 0509 |
| mb | ea | ul | gy | 0006 | 0042 | 0078 | 0114 | 0150 | 0186 | 0222 | 0258 | 0294 | 0330 | 0366 | 0402 | 0438 | 0474 | 0510 |
| mc | ee | um | gu | 0007 | 0043 | 0079 | 0115 | 0151 | 0187 | 0223 | 0259 | 0295 | 0331 | 0367 | 0403 | 0439 | 0475 | 0511 |
| md | ei | un | go | 0008 | 0044 | 0080 | 0116 | 0152 | 0188 | 0224 | 0260 | 0296 | 0332 | 0368 | 0404 | 0440 | 0476 | 0512 |
| mf | eo | up | gi | 0009 | 0045 | 0081 | 0117 | 0153 | 0189 | 0225 | 0261 | 0297 | 0333 | 0369 | 0405 | 0441 | 0477 | 0513 |
| mg | eu | ur | ge | 0010 | 0046 | 0082 | 0118 | 0154 | 0190 | 0226 | 0262 | 0298 | 0334 | 0370 | 0406 | 0442 | 0478 | 0514 |
| mk | ey | us | ga | 0011 | 0047 | 0083 | 0119 | 0155 | 0191 | 0227 | 0263 | 0299 | 0335 | 0371 | 0407 | 0443 | 0479 | 0515 |
| pb | ia | ol | fy | 0012 | 0048 | 0084 | 0120 | 0156 | 0192 | 0228 | 0264 | 0300 | 0336 | 0372 | 0408 | 0444 | 0480 | 0516 |
| pc | ie | om | fu | 0013 | 0049 | 0085 | 0121 | 0157 | 0193 | 0229 | 0265 | 0301 | 0337 | 0373 | 0409 | 0445 | 0481 | 0517 |
| pd | ii | on | fo | 0014 | 0050 | 0086 | 0122 | 0158 | 0194 | 0230 | 0266 | 0302 | 0338 | 0374 | 0410 | 0446 | 0482 | 0518 |
| pf | io | op | fi | 0015 | 0051 | 0087 | 0123 | 0159 | 0195 | 0231 | 0267 | 0303 | 0339 | 0375 | 0411 | 0447 | 0483 | 0519 |
| pg | iu | or | fe | 0016 | 0052 | 0088 | 0124 | 0160 | 0196 | 0232 | 0268 | 0304 | 0340 | 0376 | 0412 | 0448 | 0484 | 0520 |
| pk | iy | os | fa | 0017 | 0053 | 0089 | 0125 | 0161 | 0197 | 0233 | 0269 | 0305 | 0341 | 0377 | 0413 | 0449 | 0485 | 0521 |
| rb | oa | il | dy | 0018 | 0054 | 0090 | 0126 | 0162 | 0198 | 0234 | 0270 | 0306 | 0342 | 0378 | 0414 | 0450 | 0486 | 0522 |
| rc | oe | im | du | 0019 | 0055 | 0091 | 0127 | 0163 | 0199 | 0235 | 0271 | 0307 | 0343 | 0379 | 0415 | 0451 | 0487 | 0523 |
| rd | oi | in | do | 0020 | 0056 | 0092 | 0128 | 0164 | 0200 | 0236 | 0272 | 0308 | 0344 | 0380 | 0416 | 0452 | 0488 | 0524 |
| rf | oo | ip | di | 0021 | 0057 | 0093 | 0129 | 0165 | 0201 | 0237 | 0273 | 0309 | 0345 | 0381 | 0417 | 0453 | 0489 | 0525 |
| rg | ou | ir | de | 0022 | 0058 | 0094 | 0130 | 0166 | 0202 | 0238 | 0274 | 0310 | 0346 | 0382 | 0418 | 0454 | 0490 | 0526 |
| rk | oy | is | da | 0023 | 0059 | 0095 | 0131 | 0167 | 0203 | 0239 | 0275 | 0311 | 0347 | 0383 | 0419 | 0455 | 0491 | 0527 |
| sb | ua | el | cy | 0024 | 0060 | 0096 | 0132 | 0168 | 0204 | 0240 | 0276 | 0312 | 0348 | 0384 | 0420 | 0456 | 0492 | 0528 |
| sc | ue | em | cu | 0025 | 0061 | 0097 | 0133 | 0169 | 0205 | 0241 | 0277 | 0313 | 0349 | 0385 | 0421 | 0457 | 0493 | 0529 |
| sd | ui | en | co | 0026 | 0062 | 0098 | 0134 | 0170 | 0206 | 0242 | 0278 | 0314 | 0350 | 0386 | 0422 | 0458 | 0494 | 0530 |
| sf | uo | ep | ci | 0027 | 0063 | 0099 | 0135 | 0171 | 0207 | 0243 | 0279 | 0315 | 0351 | 0387 | 0423 | 0459 | 0495 | 0531 |
| sg | uu | er | ce | 0028 | 0064 | 0100 | 0136 | 0172 | 0208 | 0244 | 0280 | 0316 | 0352 | 0388 | 0424 | 0460 | 0496 | 0532 |
| sk | uy | es | ca | 0029 | 0065 | 0101 | 0137 | 0173 | 0209 | 0245 | 0281 | 0317 | 0353 | 0389 | 0425 | 0461 | 0497 | 0533 |
| tb | ya | al | by | 0030 | 0066 | 0102 | 0138 | 0174 | 0210 | 0246 | 0282 | 0318 | 0354 | 0390 | 0426 | 0462 | 0498 | 0534 |
| tc | ye | am | bu | 0031 | 0067 | 0103 | 0139 | 0175 | 0211 | 0247 | 0283 | 0319 | 0355 | 0391 | 0427 | 0463 | 0499 | 0535 |
| td | yi | an | bo | 0032 | 0068 | 0104 | 0140 | 0176 | 0212 | 0248 | 0284 | 0320 | 0356 | 0392 | 0428 | 0464 | 0500 | 0536 |
| tf | yo | ap | bi | 0033 | 0069 | 0105 | 0141 | 0177 | 0213 | 0249 | 0285 | 0321 | 0357 | 0393 | 0429 | 0465 | 0501 | 0537 |
| tg | yu | ar | be | 0034 | 0070 | 0106 | 0142 | 0178 | 0214 | 0250 | 0286 | 0322 | 0358 | 0394 | 0430 | 0466 | 0502 | 0538 |
| tk | yy | as | ba | 0035 | 0071 | 0107 | 0143 | 0179 | 0215 | 0251 | 0287 | 0323 | 0359 | 0395 | 0431 | 0467 | 0503 | 0539 |

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TABLE FOR CODING, DECODING, AND CHECKING COMMUNICATIONS.

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8 SHEETS—SHEET 4.

FIG. 4.

| COL. 1 | COL. 2 | COL. 3 | COL. 4 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lb | aa | yl | ky | 0540 | 0576 | 0612 | 0648 | 0684 | 0720 | 0756 | 0792 | 0828 | 0864 | 0900 | 0936 | 0972 | 1008 | 1044 |
| lc | ae | ym | ku | 0541 | 0577 | 0613 | 0649 | 0685 | 0721 | 0757 | 0793 | 0829 | 0865 | 0901 | 0937 | 0973 | 1009 | 1045 |
| ld | ai | yn | ko | 0542 | 0578 | 0614 | 0650 | 0686 | 0722 | 0758 | 0794 | 0830 | 0866 | 0902 | 0938 | 0974 | 1010 | 1046 |
| lf | ao | yp | ki | 0543 | 0579 | 0615 | 0651 | 0687 | 0723 | 0759 | 0795 | 0831 | 0867 | 0903 | 0939 | 0975 | 1011 | 1047 |
| lg | au | yr | ke | 0544 | 0580 | 0616 | 0652 | 0688 | 0724 | 0760 | 0796 | 0832 | 0868 | 0904 | 0940 | 0976 | 1012 | 1048 |
| lk | ay | ys | ka | 0545 | 0581 | 0617 | 0653 | 0689 | 0725 | 0761 | 0797 | 0833 | 0869 | 0905 | 0941 | 0977 | 1013 | 1049 |
| mb | ea | ul | gy | 0546 | 0582 | 0618 | 0654 | 0690 | 0726 | 0762 | 0798 | 0834 | 0870 | 0906 | 0942 | 0978 | 1014 | 1050 |
| mc | ee | um | gu | 0547 | 0583 | 0619 | 0655 | 0691 | 0727 | 0763 | 0799 | 0835 | 0871 | 0907 | 0943 | 0979 | 1015 | 1051 |
| md | ei | un | go | 0548 | 0584 | 0620 | 0656 | 0692 | 0728 | 0764 | 0800 | 0836 | 0872 | 0908 | 0944 | 0980 | 1016 | 1052 |
| mf | eo | up | gi | 0549 | 0585 | 0621 | 0657 | 0693 | 0729 | 0765 | 0801 | 0837 | 0873 | 0909 | 0945 | 0981 | 1017 | 1053 |
| mg | eu | ur | ge | 0550 | 0586 | 0622 | 0658 | 0694 | 0730 | 0766 | 0802 | 0838 | 0874 | 0910 | 0946 | 0982 | 1018 | 1054 |
| mk | ey | us | ga | 0551 | 0587 | 0623 | 0659 | 0695 | 0731 | 0767 | 0803 | 0839 | 0875 | 0911 | 0947 | 0983 | 1019 | 1055 |
| pb | ia | ol | fy | 0552 | 0588 | 0624 | 0660 | 0696 | 0732 | 0768 | 0804 | 0840 | 0876 | 0912 | 0948 | 0984 | 1020 | 1056 |
| pc | ie | om | fu | 0553 | 0589 | 0625 | 0661 | 0697 | 0733 | 0769 | 0805 | 0841 | 0877 | 0913 | 0949 | 0985 | 1021 | 1057 |
| pd | ii | on | fo | 0554 | 0590 | 0626 | 0662 | 0698 | 0734 | 0770 | 0806 | 0842 | 0878 | 0914 | 0950 | 0986 | 1022 | 1058 |
| pf | io | op | fi | 0555 | 0591 | 0627 | 0663 | 0699 | 0735 | 0771 | 0807 | 0843 | 0879 | 0915 | 0951 | 0987 | 1023 | 1059 |
| pg | iu | or | fe | 0556 | 0592 | 0628 | 0664 | 0700 | 0736 | 0772 | 0808 | 0844 | 0880 | 0916 | 0952 | 0988 | 1024 | 1060 |
| pk | iy | os | fa | 0557 | 0593 | 0629 | 0665 | 0701 | 0737 | 0773 | 0809 | 0845 | 0881 | 0917 | 0953 | 0989 | 1025 | 1061 |
| rb | oa | il | dy | 0558 | 0594 | 0630 | 0666 | 0702 | 0738 | 0774 | 0810 | 0846 | 0882 | 0918 | 0954 | 0990 | 1026 | 1062 |
| rc | oe | im | du | 0559 | 0595 | 0631 | 0667 | 0703 | 0739 | 0775 | 0811 | 0847 | 0883 | 0919 | 0955 | 0991 | 1027 | 1063 |
| rd | oi | in | do | 0560 | 0596 | 0632 | 0668 | 0704 | 0740 | 0776 | 0812 | 0848 | 0884 | 0920 | 0956 | 0992 | 1028 | 1064 |
| rf | oo | ip | di | 0561 | 0597 | 0633 | 0669 | 0705 | 0741 | 0777 | 0813 | 0849 | 0885 | 0921 | 0957 | 0993 | 1029 | 1065 |
| rg | ou | ir | de | 0562 | 0598 | 0634 | 0670 | 0706 | 0742 | 0778 | 0814 | 0850 | 0886 | 0922 | 0958 | 0994 | 1030 | 1066 |
| rk | oy | is | da | 0563 | 0599 | 0635 | 0671 | 0707 | 0743 | 0779 | 0815 | 0851 | 0887 | 0923 | 0959 | 0995 | 1031 | 1067 |
| sb | ua | el | cy | 0564 | 0600 | 0636 | 0672 | 0708 | 0744 | 0780 | 0816 | 0852 | 0888 | 0924 | 0960 | 0996 | 1032 | 1068 |
| sc | ue | em | cu | 0565 | 0601 | 0637 | 0673 | 0709 | 0745 | 0781 | 0817 | 0853 | 0889 | 0925 | 0961 | 0997 | 1033 | 1069 |
| sd | ui | en | co | 0566 | 0602 | 0638 | 0674 | 0710 | 0746 | 0782 | 0818 | 0854 | 0890 | 0926 | 0962 | 0998 | 1034 | 1070 |
| sf | uo | ep | ci | 0567 | 0603 | 0639 | 0675 | 0711 | 0747 | 0783 | 0819 | 0855 | 0891 | 0927 | 0963 | 0999 | 1035 | 1071 |
| sg | uu | er | ce | 0568 | 0604 | 0640 | 0676 | 0712 | 0748 | 0784 | 0820 | 0856 | 0892 | 0928 | 0964 | 1000 | 1036 | 1072 |
| sk | uy | es | ca | 0569 | 0605 | 0641 | 0677 | 0713 | 0749 | 0785 | 0821 | 0857 | 0893 | 0929 | 0965 | 1001 | 1037 | 1073 |
| tb | ya | al | by | 0570 | 0606 | 0642 | 0678 | 0714 | 0750 | 0786 | 0822 | 0858 | 0894 | 0930 | 0966 | 1002 | 1038 | 1074 |
| tc | ye | am | bu | 0571 | 0607 | 0643 | 0679 | 0715 | 0751 | 0787 | 0823 | 0859 | 0895 | 0931 | 0967 | 1003 | 1039 | 1075 |
| td | yi | an | bo | 0572 | 0608 | 0644 | 0680 | 0716 | 0752 | 0788 | 0824 | 0860 | 0896 | 0932 | 0968 | 1004 | 1040 | 1076 |
| tf | yo | ap | bi | 0573 | 0609 | 0645 | 0681 | 0717 | 0753 | 0789 | 0825 | 0861 | 0897 | 0933 | 0969 | 1005 | 1041 | 1077 |
| tg | yu | ar | be | 0574 | 0610 | 0646 | 0682 | 0718 | 0754 | 0790 | 0826 | 0862 | 0898 | 0934 | 0970 | 1006 | 1042 | 1078 |
| tk | yy | as | ba | 0575 | 0611 | 0647 | 0683 | 0719 | 0755 | 0791 | 0827 | 0863 | 0899 | 0935 | 0971 | 1007 | 1043 | 1079 |

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TABLE FOR CODING, DECODING, AND CHECKING COMMUNICATIONS.

APPLICATION FILED OCT. 14, 1916.

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8 SHEETS—SHEET 5.

FIG. 5.

| COL. 1 | COL. 2 | COL. 3 | COL. 4 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lb | aa | yl | ky | 1080 | 1116 | 1152 | 1188 | 1224 | 1260 | 1296 | 1332 | 1368 | 1404 | 1440 | 1476 | 1512 | 1548 | 1584 |
| lc | ae | ym | ku | 1081 | 1117 | 1153 | 1189 | 1225 | 1261 | 1297 | 1333 | 1369 | 1405 | 1441 | 1477 | 1513 | 1549 | 1585 |
| ld | ai | yn | ko | 1082 | 1118 | 1154 | 1190 | 1226 | 1262 | 1298 | 1334 | 1370 | 1406 | 1442 | 1478 | 1514 | 1550 | 1586 |
| lf | ao | yp | ki | 1083 | 1119 | 1155 | 1191 | 1227 | 1263 | 1299 | 1335 | 1371 | 1407 | 1443 | 1479 | 1515 | 1551 | 1587 |
| lg | au | yr | ke | 1084 | 1120 | 1156 | 1192 | 1228 | 1264 | 1300 | 1336 | 1372 | 1408 | 1444 | 1480 | 1516 | 1552 | 1588 |
| lk | ay | ys | ka | 1085 | 1121 | 1157 | 1193 | 1229 | 1265 | 1301 | 1337 | 1373 | 1409 | 1445 | 1481 | 1517 | 1553 | 1589 |
| mb | ea | ul | gy | 1086 | 1122 | 1158 | 1194 | 1230 | 1266 | 1302 | 1338 | 1374 | 1410 | 1446 | 1482 | 1518 | 1554 | 1590 |
| mc | ee | um | gu | 1087 | 1123 | 1159 | 1195 | 1231 | 1267 | 1303 | 1339 | 1375 | 1411 | 1447 | 1483 | 1519 | 1555 | 1591 |
| md | ei | un | go | 1088 | 1124 | 1160 | 1196 | 1232 | 1268 | 1304 | 1340 | 1376 | 1412 | 1448 | 1484 | 1520 | 1556 | 1592 |
| mf | eo | up | gi | 1089 | 1125 | 1161 | 1197 | 1233 | 1269 | 1305 | 1341 | 1377 | 1413 | 1449 | 1485 | 1521 | 1557 | 1593 |
| mg | eu | ur | ge | 1090 | 1126 | 1162 | 1198 | 1234 | 1270 | 1306 | 1342 | 1378 | 1414 | 1450 | 1486 | 1522 | 1558 | 1594 |
| mk | ey | us | ga | 1091 | 1127 | 1163 | 1199 | 1235 | 1271 | 1307 | 1343 | 1379 | 1415 | 1451 | 1487 | 1523 | 1559 | 1595 |
| pb | ia | ol | fy | 1092 | 1128 | 1164 | 1200 | 1236 | 1272 | 1308 | 1344 | 1380 | 1416 | 1452 | 1488 | 1524 | 1560 | 1596 |
| pc | ie | om | fu | 1093 | 1129 | 1165 | 1201 | 1237 | 1273 | 1309 | 1345 | 1381 | 1417 | 1453 | 1489 | 1525 | 1561 | 1597 |
| pd | ii | on | fo | 1094 | 1130 | 1166 | 1202 | 1238 | 1274 | 1310 | 1346 | 1382 | 1418 | 1454 | 1490 | 1526 | 1562 | 1598 |
| pf | io | op | fi | 1095 | 1131 | 1167 | 1203 | 1239 | 1275 | 1311 | 1347 | 1383 | 1419 | 1455 | 1491 | 1527 | 1563 | 1599 |
| pg | iu | or | fe | 1096 | 1132 | 1168 | 1204 | 1240 | 1276 | 1312 | 1348 | 1384 | 1420 | 1456 | 1492 | 1528 | 1564 | 1600 |
| pk | iy | os | fa | 1097 | 1133 | 1169 | 1205 | 1241 | 1277 | 1313 | 1349 | 1385 | 1421 | 1457 | 1493 | 1529 | 1565 | 1601 |
| rb | oa | il | dy | 1098 | 1134 | 1170 | 1206 | 1242 | 1278 | 1314 | 1350 | 1386 | 1422 | 1458 | 1494 | 1530 | 1566 | 1602 |
| rc | oe | im | du | 1099 | 1135 | 1171 | 1207 | 1243 | 1279 | 1315 | 1351 | 1387 | 1423 | 1459 | 1495 | 1531 | 1567 | 1603 |
| rd | oi | in | do | 1100 | 1136 | 1172 | 1208 | 1244 | 1280 | 1316 | 1352 | 1388 | 1424 | 1460 | 1496 | 1532 | 1568 | 1604 |
| rf | oo | ip | di | 1101 | 1137 | 1173 | 1209 | 1245 | 1281 | 1317 | 1353 | 1389 | 1425 | 1461 | 1497 | 1533 | 1569 | 1605 |
| rg | ou | ir | de | 1102 | 1138 | 1174 | 1210 | 1246 | 1282 | 1318 | 1354 | 1390 | 1426 | 1462 | 1498 | 1534 | 1570 | 1606 |
| rk | oy | is | da | 1103 | 1139 | 1175 | 1211 | 1247 | 1283 | 1319 | 1355 | 1391 | 1427 | 1463 | 1499 | 1535 | 1571 | 1607 |
| sb | ua | el | cy | 1104 | 1140 | 1176 | 1212 | 1248 | 1284 | 1320 | 1356 | 1392 | 1428 | 1464 | 1500 | 1536 | 1572 | 1608 |
| sc | ue | em | cu | 1105 | 1141 | 1177 | 1213 | 1249 | 1285 | 1321 | 1357 | 1393 | 1429 | 1465 | 1501 | 1537 | 1573 | 1609 |
| sd | ui | en | co | 1106 | 1142 | 1178 | 1214 | 1250 | 1286 | 1322 | 1358 | 1394 | 1430 | 1466 | 1502 | 1538 | 1574 | 1610 |
| sf | uo | ep | ci | 1107 | 1143 | 1179 | 1215 | 1251 | 1287 | 1323 | 1359 | 1395 | 1431 | 1467 | 1503 | 1539 | 1575 | 1611 |
| sg | uu | er | ce | 1108 | 1144 | 1180 | 1216 | 1252 | 1288 | 1324 | 1360 | 1396 | 1432 | 1468 | 1504 | 1540 | 1576 | 1612 |
| sk | uy | es | ca | 1109 | 1145 | 1181 | 1217 | 1253 | 1289 | 1325 | 1361 | 1397 | 1433 | 1469 | 1505 | 1541 | 1577 | 1613 |
| tb | ya | al | by | 1110 | 1146 | 1182 | 1218 | 1254 | 1290 | 1326 | 1362 | 1398 | 1434 | 1470 | 1506 | 1542 | 1578 | 1614 |
| tc | ye | am | bu | 1111 | 1147 | 1183 | 1219 | 1255 | 1291 | 1327 | 1363 | 1399 | 1435 | 1471 | 1507 | 1543 | 1579 | 1615 |
| td | yi | an | bo | 1112 | 1148 | 1184 | 1220 | 1256 | 1292 | 1328 | 1364 | 1400 | 1436 | 1472 | 1508 | 1544 | 1580 | 1616 |
| tf | yo | ap | bi | 1113 | 1149 | 1185 | 1221 | 1257 | 1293 | 1329 | 1365 | 1401 | 1437 | 1473 | 1509 | 1545 | 1581 | 1617 |
| tg | yu | ar | be | 1114 | 1150 | 1186 | 1222 | 1258 | 1294 | 1330 | 1366 | 1402 | 1438 | 1474 | 1510 | 1546 | 1582 | 1618 |
| tk | yy | as | ba | 1115 | 1151 | 1187 | 1223 | 1259 | 1295 | 1331 | 1367 | 1403 | 1439 | 1475 | 1511 | 1547 | 1583 | 1619 |

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TABLE FOR CODING, DECODING, AND CHECKING COMMUNICATIONS.

APPLICATION FILED OCT. 14, 1916.

1,318,366. Patented Oct. 14, 1919.

8 SHEETS—SHEET 6.

FIG. 6.

| COL. 1 | COL. 2 | COL. 3 | COL. 4 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lb | aa | yl | ky. | 1620 | 1656 | 1692 | 1728 | 1764 | 1800 | 1836 | 1872 | 1908 | 1944 | 1980 | 2016 | 2052 | 2088 | 2124 |
| lc | ae | ym | ku | 1621 | 1657 | 1693 | 1729 | 1765 | 1801 | 1837 | 1873 | 1909 | 1945 | 1981 | 2017 | 2053 | 2089 | 2125 |
| ld | ai | yn | ko | 1622 | 1658 | 1694 | 1730 | 1766 | 1802 | 1838 | 1874 | 1910 | 1946 | 1982 | 2018 | 2054 | 2090 | 2126 |
| lf | ao | yp | ki | 1623 | 1659 | 1695 | 1731 | 1767 | 1803 | 1839 | 1875 | 1911 | 1947 | 1983 | 2019 | 2055 | 2091 | 2127 |
| lg | au | yr | ke | 1624 | 1660 | 1696 | 1732 | 1768 | 1804 | 1840 | 1876 | 1912 | 1948 | 1984 | 2020 | 2056 | 2092 | 2128 |
| lk | ay | ys | ka | 1625 | 1661 | 1697 | 1733 | 1769 | 1805 | 1841 | 1877 | 1913 | 1949 | 1985 | 2021 | 2057 | 2093 | 2129 |
| mb | ea | ul | gy | 1626 | 1662 | 1698 | 1734 | 1770 | 1806 | 1842 | 1878 | 1914 | 1950 | 1986 | 2022 | 2058 | 2094 | 2130 |
| mc | ee | um | gu | 1627 | 1663 | 1699 | 1735 | 1771 | 1807 | 1843 | 1879 | 1915 | 1951 | 1987 | 2023 | 2059 | 2095 | 2131 |
| md | ei | un | go | 1628 | 1664 | 1700 | 1736 | 1772 | 1808 | 1844 | 1880 | 1916 | 1952 | 1988 | 2024 | 2060 | 2096 | 2132 |
| mf | eo | up | gi | 1629 | 1665 | 1701 | 1737 | 1773 | 1809 | 1845 | 1881 | 1917 | 1953 | 1989 | 2025 | 2061 | 2097 | 2133 |
| mg | eu | ur | ge | 1630 | 1666 | 1702 | 1738 | 1774 | 1810 | 1846 | 1882 | 1918 | 1954 | 1990 | 2026 | 2062 | 2098 | 2134 |
| mk | ey | us | ga | 1631 | 1667 | 1703 | 1739 | 1775 | 1811 | 1847 | 1883 | 1919 | 1955 | 1991 | 2027 | 2063 | 2099 | 2135 |
| pb | ia | ol | fy | 1632 | 1668 | 1704 | 1740 | 1776 | 1812 | 1848 | 1884 | 1920 | 1956 | 1992 | 2028 | 2064 | 2100 | 2136 |
| pc | ie | om | fu | 1633 | 1669 | 1705 | 1741 | 1777 | 1813 | 1849 | 1885 | 1921 | 1957 | 1993 | 2029 | 2065 | 2101 | 2137 |
| pd | ii | on | fo | 1634 | 1670 | 1706 | 1742 | 1778 | 1814 | 1850 | 1886 | 1922 | 1958 | 1994 | 2030 | 2066 | 2102 | 2138 |
| pf | io | op | fi | 1635 | 1671 | 1707 | 1743 | 1779 | 1815 | 1851 | 1887 | 1923 | 1959 | 1995 | 2031 | 2067 | 2103 | 2139 |
| pg | iu | or | fe | 1636 | 1672 | 1708 | 1744 | 1780 | 1816 | 1852 | 1888 | 1924 | 1960 | 1996 | 2032 | 2068 | 2104 | 2140 |
| pk | iy | os | fa | 1637 | 1673 | 1709 | 1745 | 1781 | 1817 | 1853 | 1889 | 1925 | 1961 | 1997 | 2033 | 2069 | 2105 | 2141 |
| rb | oa | il | dy | 1638 | 1674 | 1710 | 1746 | 1782 | 1818 | 1854 | 1890 | 1926 | 1962 | 1998 | 2034 | 2070 | 2106 | 2142 |
| rc | oe | im | du | 1639 | 1675 | 1711 | 1747 | 1783 | 1819 | 1855 | 1891 | 1927 | 1963 | 1999 | 2035 | 2071 | 2107 | 2143 |
| rd | oi | in | do | 1640 | 1676 | 1712 | 1748 | 1784 | 1820 | 1856 | 1892 | 1928 | 1964 | 2000 | 2036 | 2072 | 2108 | 2144 |
| rf | oo | ip | di | 1641 | 1677 | 1713 | 1749 | 1785 | 1821 | 1857 | 1893 | 1929 | 1965 | 2001 | 2037 | 2073 | 2109 | 2145 |
| rg | ou | ir | de | 1642 | 1678 | 1714 | 1750 | 1786 | 1822 | 1858 | 1894 | 1930 | 1966 | 2002 | 2038 | 2074 | 2110 | 2146 |
| rk | oy | is | da | 1643 | 1679 | 1715 | 1751 | 1787 | 1823 | 1859 | 1895 | 1931 | 1967 | 2003 | 2039 | 2075 | 2111 | 2147 |
| sb | ua | el | cy | 1644 | 1680 | 1716 | 1752 | 1788 | 1824 | 1860 | 1896 | 1932 | 1968 | 2004 | 2040 | 2076 | 2112 | 2148 |
| sc | ue | em | cu | 1645 | 1681 | 1717 | 1753 | 1789 | 1825 | 1861 | 1897 | 1933 | 1969 | 2005 | 2041 | 2077 | 2113 | 2149 |
| sd | ui | en | co | 1646 | 1682 | 1718 | 1754 | 1790 | 1826 | 1862 | 1898 | 1934 | 1970 | 2006 | 2042 | 2078 | 2114 | 2150 |
| sf | uo | ep | ci | 1647 | 1683 | 1719 | 1755 | 1791 | 1827 | 1863 | 1899 | 1935 | 1971 | 2007 | 2043 | 2079 | 2115 | 2151 |
| sg | uu | er | ce | 1648 | 1684 | 1720 | 1756 | 1792 | 1828 | 1864 | 1900 | 1936 | 1972 | 2008 | 2044 | 2080 | 2116 | 2152 |
| sk | uy | es | ca | 1649 | 1685 | 1721 | 1757 | 1793 | 1829 | 1865 | 1901 | 1937 | 1973 | 2009 | 2045 | 2081 | 2117 | 2153 |
| tb | ya | al | by | 1650 | 1686 | 1722 | 1758 | 1794 | 1830 | 1866 | 1902 | 1938 | 1974 | 2010 | 2046 | 2082 | 2118 | 2154 |
| tc | ye | am | bu | 1651 | 1687 | 1723 | 1759 | 1795 | 1831 | 1867 | 1903 | 1939 | 1975 | 2011 | 2047 | 2083 | 2119 | 2155 |
| td | yi | an | bo | 1652 | 1688 | 1724 | 1760 | 1796 | 1832 | 1868 | 1904 | 1940 | 1976 | 2012 | 2048 | 2084 | 2120 | 2156 |
| tf | yo | ap | bi | 1653 | 1689 | 1725 | 1761 | 1797 | 1833 | 1869 | 1905 | 1941 | 1977 | 2013 | 2049 | 2085 | 2121 | 2157 |
| tg | yu | ar | be | 1654 | 1690 | 1726 | 1762 | 1798 | 1834 | 1870 | 1906 | 1942 | 1978 | 2014 | 2050 | 2086 | 2122 | 2158 |
| tk | yy | as | ba | 1655 | 1691 | 1727 | 1763 | 1799 | 1835 | 1871 | 1907 | 1943 | 1979 | 2015 | 2051 | 2087 | 2123 | 2159 |

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TABLE FOR CODING, DECODING, AND CHECKING COMMUNICATIONS.
APPLICATION FILED OCT. 14, 1916.
1,318,366. Patented Oct. 14, 1919.
8 SHEETS—SHEET 7.

FIG. 7.

| COL. 1 | COL. 2 | COL. 3 | COL. 4 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lb | aa | yl | ky | 2160 | 2196 | 2232 | 2268 | 2304 | 2340 | 2376 | 2412 | 2448 | 2484 | 2520 | 2556 | 2592 | 2628 | 2664 |
| lc | ae | ym | ku | 2161 | 2197 | 2233 | 2269 | 2305 | 2341 | 2377 | 2413 | 2449 | 2485 | 2521 | 2557 | 2593 | 2629 | 2665 |
| ld | ai | yn | ko | 2162 | 2198 | 2234 | 2270 | 2306 | 2342 | 2378 | 2414 | 2450 | 2486 | 2522 | 2558 | 2594 | 2630 | 2666 |
| lf | ao | yp | ki | 2163 | 2199 | 2235 | 2271 | 2307 | 2343 | 2379 | 2415 | 2451 | 2487 | 2523 | 2559 | 2595 | 2631 | 2667 |
| lg | au | yr | ke | 2164 | 2200 | 2236 | 2272 | 2308 | 2344 | 2380 | 2416 | 2452 | 2488 | 2524 | 2560 | 2596 | 2632 | 2668 |
| lk | ay | ys | ka | 2165 | 2201 | 2237 | 2273 | 2309 | 2345 | 2381 | 2417 | 2453 | 2489 | 2525 | 2561 | 2597 | 2633 | 2669 |
| mb | ea | ul | gy | 2166 | 2202 | 2238 | 2274 | 2310 | 2346 | 2382 | 2418 | 2454 | 2490 | 2526 | 2562 | 2598 | 2634 | 2670 |
| mc | ee | um | gu | 2167 | 2203 | 2239 | 2275 | 2311 | 2347 | 2383 | 2419 | 2455 | 2491 | 2527 | 2563 | 2599 | 2635 | 2671 |
| md | ei | un | go | 2168 | 2204 | 2240 | 2276 | 2312 | 2348 | 2384 | 2420 | 2456 | 2492 | 2528 | 2564 | 2600 | 2636 | 2672 |
| mf | eo | up | gi | 2169 | 2205 | 2241 | 2277 | 2313 | 2349 | 2385 | 2421 | 2457 | 2493 | 2529 | 2565 | 2601 | 2637 | 2673 |
| mg | eu | ur | ge | 2170 | 2206 | 2242 | 2278 | 2314 | 2350 | 2386 | 2422 | 2458 | 2494 | 2530 | 2566 | 2602 | 2638 | 2674 |
| mk | ey | us | ga | 2171 | 2207 | 2243 | 2279 | 2315 | 2351 | 2387 | 2423 | 2459 | 2495 | 2531 | 2567 | 2603 | 2639 | 2675 |
| pb | ia | ol | fy | 2172 | 2208 | 2244 | 2280 | 2316 | 2352 | 2388 | 2424 | 2460 | 2496 | 2532 | 2568 | 2604 | 2640 | 2676 |
| pc | ie | om | fu | 2173 | 2209 | 2245 | 2281 | 2317 | 2353 | 2389 | 2425 | 2461 | 2497 | 2533 | 2569 | 2605 | 2641 | 2677 |
| pd | ii | on | fo | 2174 | 2210 | 2246 | 2282 | 2318 | 2354 | 2390 | 2426 | 2462 | 2498 | 2534 | 2570 | 2606 | 2642 | 2678 |
| pf | io | op | fi | 2175 | 2211 | 2247 | 2283 | 2319 | 2355 | 2391 | 2427 | 2463 | 2499 | 2535 | 2571 | 2607 | 2643 | 2679 |
| pg | iu | or | fe | 2176 | 2212 | 2248 | 2284 | 2320 | 2356 | 2392 | 2428 | 2464 | 2500 | 2536 | 2572 | 2608 | 2644 | 2680 |
| pk | iy | os | fa | 2177 | 2213 | 2249 | 2285 | 2321 | 2357 | 2393 | 2429 | 2465 | 2501 | 2537 | 2573 | 2609 | 2645 | 2681 |
| rb | oa | il | dy | 2178 | 2214 | 2250 | 2286 | 2322 | 2358 | 2394 | 2430 | 2466 | 2502 | 2538 | 2574 | 2610 | 2646 | 2682 |
| rc | oe | im | du | 2179 | 2215 | 2251 | 2287 | 2323 | 2359 | 2395 | 2431 | 2467 | 2503 | 2539 | 2575 | 2611 | 2647 | 2683 |
| rd | oi | in | do | 2180 | 2216 | 2252 | 2288 | 2324 | 2360 | 2396 | 2432 | 2468 | 2504 | 2540 | 2576 | 2612 | 2648 | 2684 |
| rf | oo | ip | di | 2181 | 2217 | 2253 | 2289 | 2325 | 2361 | 2397 | 2433 | 2469 | 2505 | 2541 | 2577 | 2613 | 2649 | 2685 |
| rg | ou | ir | de | 2182 | 2218 | 2254 | 2290 | 2326 | 2362 | 2398 | 2434 | 2470 | 2506 | 2542 | 2578 | 2614 | 2650 | 2686 |
| rk | oy | is | da | 2183 | 2219 | 2255 | 2291 | 2327 | 2363 | 2399 | 2435 | 2471 | 2507 | 2543 | 2579 | 2615 | 2651 | 2687 |
| sb | ua | el | cy | 2184 | 2220 | 2256 | 2292 | 2328 | 2364 | 2400 | 2436 | 2472 | 2508 | 2544 | 2580 | 2616 | 2652 | 2688 |
| sc | ue | em | cu | 2185 | 2221 | 2257 | 2293 | 2329 | 2365 | 2401 | 2437 | 2473 | 2509 | 2545 | 2581 | 2617 | 2653 | 2689 |
| sd | ui | en | co | 2186 | 2222 | 2258 | 2294 | 2330 | 2366 | 2402 | 2438 | 2474 | 2510 | 2546 | 2582 | 2618 | 2654 | 2690 |
| sf | uo | ep | ci | 2187 | 2223 | 2259 | 2295 | 2331 | 2367 | 2403 | 2439 | 2475 | 2511 | 2547 | 2583 | 2619 | 2655 | 2691 |
| sg | uu | er | ce | 2188 | 2224 | 2260 | 2296 | 2332 | 2368 | 2404 | 2440 | 2476 | 2512 | 2548 | 2584 | 2620 | 2656 | 2692 |
| sk | uy | es | ca | 2189 | 2225 | 2261 | 2297 | 2333 | 2369 | 2405 | 2441 | 2477 | 2513 | 2549 | 2585 | 2621 | 2657 | 2693 |
| tb | ya | al | by | 2190 | 2226 | 2262 | 2298 | 2334 | 2370 | 2406 | 2442 | 2478 | 2514 | 2550 | 2586 | 2622 | 2658 | 2694 |
| tc | ye | am | bu | 2191 | 2227 | 2263 | 2299 | 2335 | 2371 | 2407 | 2443 | 2479 | 2515 | 2551 | 2587 | 2623 | 2659 | 2695 |
| td | yi | an | bo | 2192 | 2228 | 2264 | 2300 | 2336 | 2372 | 2408 | 2444 | 2480 | 2516 | 2552 | 2588 | 2624 | 2660 | 2696 |
| tf | yo | ap | bi | 2193 | 2229 | 2265 | 2301 | 2337 | 2373 | 2409 | 2445 | 2481 | 2517 | 2553 | 2589 | 2625 | 2661 | 2697 |
| tg | yu | ar | be | 2194 | 2230 | 2266 | 2302 | 2338 | 2374 | 2410 | 2446 | 2482 | 2518 | 2554 | 2590 | 2626 | 2662 | 2698 |
| tk | yy | as | ba | 2195 | 2231 | 2267 | 2303 | 2339 | 2375 | 2411 | 2447 | 2483 | 2519 | 2555 | 2591 | 2627 | 2663 | 2699 |

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8 SHEETS—SHEET 8.

FIG. 8.

| 00 | 01 | 02 | 03 | 04 | 05 | 06 | |
|---|---|---|---|---|---|---|---|
| az | bm | cy | dl | ex | fk | gw | 00 |
| hj | iv | ji | ku | lh | mt | ng | 01 |
| os | pf | qr | re | sq | td | up | 02 |
| vc | wo | xb | yn | za | am | by | 03 |
| cl | dx | ek | fw | gj | hv | ii | 04 |
| ju | kh | lt | mg | ns | of | pr | 05 |
| qe | rq | sd | tp | uc | vo | wb | 06 |
| xn | ya | zz | ay | bl | cx | dk | 07 |
| ew | fj | gv | hi | iu | jh | kt | 08 |
| lg | ms | nf | or | pe | qq | rd | 09 |
| sp | tc | uo | vb | wn | xa | yz | 10 |
| zm | al | bx | ck | dw | ej | fv | 11 |
| gi | hu | ih | jt | kg | ls | mf | 12 |
| nr | oe | pq | qd | rp | sc | to | 13 |
| ub | vn | wa | xz | ym | zy | ax | 14 |
| bk | cw | dj | ev | fi | gu | hh | 15 |
| it | jg | ks | lf | mr | ne | oq | 16 |
| pd | qp | rc | so | tb | un | va | 17 |
| wz | xm | yy | zl | ak | bw | cj | 18 |
| dv | ei | fu | gh | ht | ig | js | 19 |
| kf | lr | me | nq | od | pp | qc | 20 |
| ro | sb | tn | ua | vz | wm | xy | 21 |
| yl | zx | aw | bj | cv | di | eu | 22 |
| fh | gt | hg | is | jf | kr | le | 23 |
| mq | nd | op | pc | qo | rb | sn | 24 |
| ta | uz | vm | wy | xl | yx | zk | 25 |
| aj | bv | ci | du | eh | ft | gg | 26 |
| hs | if | jr | ke | lq | md | np | 27 |
| oc | po | qb | rn | sa | tz | um | 28 |
| vy | wl | xx | yk | zw | av | bi | 29 |
| cu | dh | et | fg | gs | hf | ir | 30 |
| je | kq | ld | mp | nc | oo | pb | 31 |
| qn | ra | sz | tm | uy | vl | wx | 32 |
| xk | yw | zj | ai | bu | ch | dt | 33 |
| eg | fs | gf | hr | ie | jq | kd | 34 |
| lp | mc | no | ob | pn | qa | rz | 35 |
| sm | ty | ul | vx | wk | xw | yj | 36 |
| zv | au | bh | ct | dg | es | ff | 37 |
| gr | he | iq | jd | kp | lc | mo | 38 |
| nb | on | pa | qz | rm | sy | tl | 39 |
| ux | vk | ww | xj | yv | zi | ah | 40 |
| bt | cg | ds | ef | fr | ge | hq | 41 |
| id | jp | kc | lo | mb | nn | oa | 42 |
| pz | qm | ry | sl | tx | uk | vw | 43 |
| wj | xv | yi | zu | at | bg | cs | 44 |
| df | er | fe | gq | hd | ip | jc | 45 |
| ko | lb | mn | na | oz | pm | qy | 46 |
| rl | sx | tk | uw | vj | wv | xi | 47 |
| yu | zh | ag | bs | cf | dr | ee | 48 |
| fq | gd | hp | ic | jo | kb | ln | 49 |
| ma | nz | om | py | ql | rx | sk | 50 |

| 00 | 01 | 02 | 03 | 04 | 05 | 06 | |
|---|---|---|---|---|---|---|---|
| tw | uj | vv | wi | xu | yh | zt | 51 |
| as | bf | cr | de | eq | fd | gp | 52 |
| hc | io | jb | kn | la | mz | nm | 53 |
| oy | pl | qx | rk | sw | tj | uv | 54 |
| vi | wu | xh | yt | zg | af | br | 55 |
| ce | dq | ed | fp | gc | ho | ib | 56 |
| jn | ka | lz | mm | ny | ol | px | 57 |
| qk | rw | sj | tv | ui | vu | wh | 58 |
| xt | yg | zs | ar | be | cq | dd | 59 |
| ep | fc | go | hb | in | ja | kz | 60 |
| lm | my | nl | ox | pk | qw | rj | 61 |
| sv | ti | uu | vh | wt | xg | ys | 62 |
| zf | ae | bq | cd | dp | ec | fo | 63 |
| gb | hn | ia | jz | km | ly | ml | 64 |
| nx | ok | pw | qj | rv | si | tu | 65 |
| uh | vt | wg | xs | yf | zr | aq | 66 |
| bd | cp | dc | eo | fb | gn | ha | 67 |
| iz | jm | ky | ll | mx | nk | ow | 68 |
| pj | qv | ri | su | th | ut | vg | 69 |
| ws | xf | yr | ze | ad | bp | cc | 70 |
| do | eb | fn | ga | hz | im | jy | 71 |
| kl | lx | mk | nw | oj | pv | qi | 72 |
| ru | sh | tt | ug | vs | wf | xr | 73 |
| ye | zq | ap | bc | co | db | en | 74 |
| fa | gz | hm | iy | jl | kx | lk | 75 |
| mw | nj | ov | pi | qu | rh | | 76 |
| st | tg | us | vf | wr | xe | | 77 |
| yq | zd | ac | bo | cb | dn | | 78 |
| ea | fz | gm | hy | il | jx | | 79 |
| kk | lw | mj | nv | oi | pu | | 80 |
| qh | rt | sg | ts | uf | vr | | 81 |
| we | xq | yd | zp | ao | bb | | 82 |
| cn | da | ez | fm | gy | hl | | 83 |
| ix | jk | kw | lj | mv | ni | | 84 |
| ou | ph | qt | rg | ss | tf | | 85 |
| ur | ve | wq | xd | yp | zc | | 86 |
| ab | bn | ca | dz | em | fy | | 87 |
| gl | hx | ik | jw | kj | lv | | 88 |
| mi | nu | oh | pt | qg | rs | | 89 |
| sf | tr | ue | vq | wd | xp | | 90 |
| yc | zo | an | ba | cz | dm | | 91 |
| ey | fl | gx | hk | iw | jj | | 92 |
| kv | li | mu | nh | ot | pg | | 93 |
| qs | rf | sr | te | uq | vd | | 94 |
| wp | xc | yo | zb | aa | bz | | 95 |
| cm | dy | el | fx | gk | hw | | 96 |
| ij | jv | ki | lu | mh | nt | | 97 |
| og | ps | qf | rr | se | tq | | 98 |
| ud | vp | wc | xo | yb | zn | | 99 |

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## TABLE FOR CODING, DECODING, AND CHECKING COMMUNICATIONS.

1,318,366. Specification of Letters Patent. Patented Oct. 14, 1919.

Application filed October 14, 1916. Serial No. 125,609.

*To all whom it may concern:*

Be it known that I, COSMO FARQUHAR, a citizen of Great Britain, residing at Rutherford, in the county of Bergen and State of New Jersey, have invented certain new and useful Improvements in Tables for Coding, Decoding, and Checking Communications, of which the following is a specification.

The invention relates to a cipher-book comprising one or more tables for use in coding, decoding, and checking communications, the term "book" being used herein in its broad significance to apply to a single sheet as well as to a group of sheets, and to the latter whether they are bound or loose.

While the invention may be used in connection with all transcribed communications, it is particularly advantageous in connection with cable codes; and in the further consideration thereof its use in connection with cable codes will be described, for with that understanding of the invention its use in connection with other communications will be readily comprehended. I have selected two well-known systems of codes as a means of illustrating the use of my invention without, however, intending in any way to be limited thereby; one, in which groups of letters are used to indicate a message or a part of a message, and the other in which groups of numerals are used for this purpose. In the latter system it is common practice in code books to have equivalent letter designations for the numerical message cipher in order that, if desired, the numerals can be readily translated into letters. My invention contemplates that when the numeral system is employed this translation shall be made so that the resultant code message will be transmitted by letters rather than numerals.

The present practice of the cable companies is to permit a ten-letter combination to be sent for a unit word price, provided the combination constitutes a word which is pronounceable by syllable. One difficulty with the present system is that the letters comprising the combination, whether they are originally used or are the result of a translation from numerals, have no natural connection between them to assist in the proper translation whether pronounceable by syllable or not. As a result, mistakes commonly occur, both in the letters themselves and in the order thereof. There is a great desirability therefore, for a means by which ten-letter combinations can be made into self-checking pronounceable words, and such is one of the objects of my invention.

Furthermore, if a cablegram has been erroneously transmitted under the present practice, it is necessary to cable back to the sending station that there has been an error in coding or in transmission and to recable the message correctly. This delay and the expense incident to correcting the errors are very objectionable; and a further object of my invention is the production of means to aid in correcting an erroneous message, without the necessity of recabling the message corrected.

In order that the invention may be the more readily understood, a brief outline of the common practice of coding and decoding messages is now given. In the letter-method, a common practice is to make use of a combination of five letters as a code symbol to designate the message desired to be sent, or a part thereof, and to have each of said five-letter groups, to which arbitrary meanings have been assigned, vary from the others by two letters. This latter is referred to as a two-letter variation. When a message is to be transmitted, it is reduced to these five letter groups, and if two consecutive groups can be combined into a ten-letter group which is pronounceable by syllable, this is done as above indicated. If not a unit word charge is made for each five-letter group. For example, it may be desired to send the following cablegram, "Send power, drawing and specification for Greece—send forms of power for assignment of patent in Austria". The first part of this message in a certain code may have been given the arbitrary letter combination *abbcd*, and the second part, the letter combination *debdm*. The combination of these, *abbcddebdm*, is obviously unpronounceable by syllable and must be sent as two words.

Supposing, however, that the last letter of the first group "*d*", be replaced by a vowel, as, for example *i*, and the last letter of the

second group, "*m*", by, for example, the vowel *u*, the result of such substitution is the combination *abbcidebdu*, a pronounceable word which can be sent for the unit word price. If now, the letters *i u* can also serve as a check on the message so that its correctness can be ascertained, and if at the same time the substitution of these letters for the fifth and tenth letters of the unpronounceable combination does not interfere with the proper decoding thereof, a considerable advance has been made in the art by the transmission of messages by code, and such advance is one of the things which is accomplished by my invention.

Considering now the numeral code method, assume that it is desired to send the following message: "Please apply for an extension of time—no model has come to hand". The first part of this message in a certain numeral code may have been given the arbitrary numeral combination 08734, and the second part the numeral combination 04617. In the particular code considered, it may be found that the first of these groups of numerals is equivalent to the letter group *abegm*, and the second numeral group, to the letter group *hopdn*. These combine to form the combination *abegmhopdn*, obviously an unpronounceable combination, which must be sent as two words. If, however, the last letter, "*m*", of the first group be replaced by, for example the vowel *a*, and the last letter "*n*," of the second group by, for example, the vowel *u*, the resultant combination is *abegahopdu*, a pronounceable combination, which can be sent for the unit word price. It is also common practice in the numeral cipher codes to employ the two-letter variation in the equivalent letter groups so that my invention can be applied thereto as in the case of the letter cipher codes.

Assume now the first of the illustrative code message ciphers, "*abbcidebdu*", has been received as, for example, *abdcidebdu*: as will be fully explained below, this error can be at once detected by means of my checking system. Having discovered this error, the question arises how it can be corrected without the necessity of recabling. As stated before, one of the objects of the invention is the production of means for discovering such an error.

As an example of a variation in codes of the characters referred to might be cited the codes in which four-letter groups are employed instead of five-letter groups. In such cases instead of replacing the last letter of each group, a letter would be added at the end of each group.

In the cipher book of the preferred form of the invention there are assigned numerical equivalents for all of the possible groups of two letters each, and the book is divided into tables for ready use. In one of the tables are assembled in groups of two, all of the letters which are used in transmitting the message itself; in another table are assembled in two-letter groups the letters which are intended either to be substituted for certain of the letters of the message cipher groups or to be added thereto, the groups being given series of numerical equivalents: and in the third table are assembled in two-letter groups the letters and numerical equivalents of the table first referred to but in a different manner. This table is primarily intended to aid in detecting the errors of a wrongly transmitted message, and is a convenient although not necessary supplement to the first mentioned table.

To aid in the understanding of my invention I have illustrated in the drawings which form a part of this application examples of said tables, but I do not wish to be understood to be limited to the precise tables illustrated, as other tables, combinations, and numerical equivalents embodying my invention may be devised by those skilled in the art. In these drawings—

Figures 1 and 2 illustrate a table in which all of the letters of the alphabet are combined alphabetically in all of the possible two-letter combinations thereof, each combination being given an arbitary numerical equivalent differing from that of any other combination. These figures illustrate the table which is intended primarily for use in connection with the letters of a cablegram designating the message itself;

Figs. 3, 4, 5, 6, and 7 illustrate a table in which certain of the letters of the alphabet are arranged in four columns of two-letter groups, with a series of arbitrary numerical equivalents assigned to the corresponding groups of each column, the numerals being arranged in columns in numerical order down the columns. In these figures the letter columns are repeated to permit of illustration herein. This table is primarily for use for substituting certain letters of the cable message cipher groups, or for addition thereto, to render them pronounceable and self-checking.

Fig. 8 illustrates a table in which the two-letter groups of Figs. 1 and 2 (having the same numerical equivalents as in said figures) are arranged in columns and lines with the numerical equivalents indicated partly above and partly at the side of the columns. The list of numerals above the columns indicates the thousands and hundreds values of the groups in the columns beneath, and the numerals at the side of the columns indicate the tens and units values of the groups in the lines adjacent thereto. These figures illustrate a table which is in-

tended primarily to aid in detecting the errors of a wrongly transmitted message.

In the table of Figs. 1 and 2 the two-letter groups are arranged alphabetically according to their first letters, and the second letters of the groups are arranged alphabetically with each letter of the alphabet; and for convenience in use each series thus formed is separated from the others by spaces. Thus in the first series so spaced off there occurs, down the columns, *aa*, *ab*, *ac*, *ad*, and so on to and including *az;* in the second series of groups there occurs *ba*, *bb*, *bc*, *bd;* and so on to the end of the series.

Each two-letter group has been given a numerical equivalent and although there is no single two-letter group which has a numerical equivalent as high as 1000, the equivalents are conveniently expressed in four figures; thus *aa* has the numerical equivalent 495 expressed as 0495; *ab*, the numerical equivalent 87 expressed at 0087; *hj*, the numerical equivalent 1 expressed as 0001; *az*, the numerical equivalent 0 expressed as 0000.

In the tables of Figs. 3 to 7 inclusive there are four columns of two-letter groups arranged with four groups in each line. In the first column each group is made up of two consonants; in the second column, of two vowels, (considering *y* a vowel); in the third column, of a vowel followed by a consonant; and in the fourth column, of a consonant followed by a vowel. The two-letter groups in each of the columns are arranged alphabetically down the columns with the same general arrangement as already described in connection with the table of Figs. 1 and 2. Thus, considering the first column, there occur the two-letter groups commencing with *l*, the consonants combined therewith following in alphabetical order; for example, *lb*, *lc*, *ld*, etc. This is followed by the *m* groups, and the *m* groups by the *p* groups, etc. For convenience, each of these letter columns are designated in some suitable way as by the legends, "Col. 1", "Col. 2", "Col. 3", "Col. 4".

The letter group columns are followed by a series of numerical group columns in which there are seventy-five different equivalents assigned to the two-letter groups of each line of letters. These numerical equivalents start with 0 and advance numerically one by one down the columns until they have reached a sufficiently high figure for the purposes of my method, as shown, up to and including 2699. For convenience in the use of the table, the equivalents are expressed in four digits however large the equivalent may be, thus *lb*, *aa*, *yl*, and *ky* each have as one equivalent 0 (expressed as 0000); *lc*, *ae*, *ym*, *ku*, as one equivalent 1, (expressed as 0001); *pg*, *iu*, *or*, *fe*, as one equivalent 16 (expressed as 0016); all of these equivalents being taken from the first column. As illustrating the other equivalents, which each of these groups has from the other fifty-nine columns, *lb*, *aa*, *yl*, *ky*, each has the equivalents 36 (expressed as 0036), 72 (expressed as 0072), 468 (expressed as 0468), 900 (expressed as 0900), 1476, 1980, and 2664; *lc*, *ae*, *ym*, *ku*, each has the equivalents 145 (expressed as 0145), 433 (expressed as 0433), 757 (expressed as 0757), 1369, 1909 and 2593; *pg*, *iu*, *or*, *fe*, each has the equivalents 268 (expressed as 0268), 844 (expressed as 0844), and 2572.

In the table of Fig. 8, in which the two-letter combinations have numerical equivalents of the table of Figs. 1 and 2, the arrangement is made with a view of working from the numerical equivalent to the letter group. Although the table is in two large columns, it is obvious that the second large column follows on from the bottom of the first column, and in the discussion thereof would be considered as one continuous large column.

It has already been explained that none of these groups have equivalents in the thousands and that the equivalents of all of the groups are expressed in four figures.

With this understanding, it will be seen that there are seven columns of two-letter groups. In the first column occur all of the two-letter groups which have no equivalents in hundreds; in the second column, all of the two-letter groups which have equivalents in one-hundreds; in the third, all which have equivalents in the two-hundreds; in the fourth, all which have equivalents in the three-hundreds; in the fifth, all which have equivalents in the four-hundreds; in the sixth, all which have equivalents in the five-hundreds; and in the seventh, all which have equivalents in the six-hundreds. These values are indicated above the columns respectively as follows: 00, 01, 02, 03, 04, 05, and 06. Thus for example the first two numerals of the four-numeral equivalents of *az* are 00; of *bm*, 01; of *bx*, 02; *hz*, 04; *zn*, 05.

Reading the table across the columns, in the first line of two-letter groups occur all of the groups which have no numerical equivalents in tens or units; in the second line, all which have no numerical equivalents in tens, but the unit equivalent of which is 1; in the third line, all which have no numerical equivalents in tens but the unit equivalent of which is 2, and so on down the column up to and including 99. Thus, for example, the last two numerals of the four numeral equivalent of *az* is 00; of *hj*, 01; of *bx*, 11; *hz*, 71; *zn*, 99.

If the thousands and hundreds values of the repeated two-letter groups chosen for

illustration, be combined with the tens and units values thereof, the following four numeral groups are obtained:

*az* 0000,
*bx* 0211,
*hz* 0471,
*zn* 0599.

Referring now to the table of Figs. 1 and 2, it will be seen that these are the numerical equivalents there given.

To make use of the table of Fig. 8 in going from numerical groups to letters, the line of figures is referred to for the thousands and hundreds and the columns of figures for tens and units. Assume for illustration that it is desired to find the two-letter group equivalent of the numeral 0336. Referring to the line of figures at the top of the columns, it is seen that the letter group will occur in the fourth column: referring to the column of figures at the side of the letter groups the numeral 36 is located. The two-letter group desired will therefore be found in the fourth column in the line opposite 36 and is *vx*. On reference to the table of Figs. 1 and 2, it is seen that the equivalent of *vx* there found is 0336.

For convenience in the use of this table, spaces are made between the lines 10 and 11, 20 and 21, 30 and 31, and so on by tens: this is obviously optional. Furthermore, it might be noted that the seventh column is not as long as the preceding six columns, but stops with the two-letter group *lk* and the tens and units values 75, as the values of the two-letter groups of Figs. 1 and 2 are then all accounted for.

The method of coding, decoding, and checking cablegrams and the use of the cipher-book proceeds along the following lines:

Having coded the message for transmittal into the ordinary message cipher in ten-letter combinations composed of two groups of five letters each, whether from a letter code or from a numeral code translated into letters, the last letter of each group forming the ten-letter combination is struck out, and the first four letters of each of said groups are paired off in the order found into two-letter groups. The numeral equivalents of each of these two-letter groups are then obtained from the table of Figs. 1 and 2 or similar tables, and added.

Next, turn to the table of Figs. 3 to 7 inclusive, or a similar table, and locate the numeral group which is found by making this addition. The letters to be supplied for those struck out from the ten-letter combinations will be found in the line in which this numeral group is located and must be chosen from the four two-letter groups in that line. If the fourth letters of the two groups forming the ten letter combination are both vowels, the two-letter checking groups should be chosen from column 1; if the fourth letters of the two-letter groups forming the ten letter combination are both consonants, the two-letter checking groups should be chosen from column 2; if the fourth letter of the first group is a consonant and of the second group a vowel, the two-letter checking group should be chosen from column 3; if the fourth letter of the first group is a vowel and of the second group a consonant, the two-letter checking group should be chosen from column 4. Having chosen the two letter checking group, the first of the two letters thereof is substituted for the letter which was struck from the end of the first message cipher and the second of the two-letter checking group for the letter which was struck from the end of the second message cipher group, a ten-letter combination which is pronounceable and self-checking thus being formed.

To illustrate, consider the first example given in the preamble, to wit, *abbcd debdm*, strike out the *d* of the first five-letter group and the *m* of the second five-letter group. This leaves *abbc debd*, or, divided in accordance with the above, *ab bc de bd*. The numerical equivalents for these two combinations found in the table of Figs. 1 and 2, added, are as follows:

| | | | | | |
|---|---|---|---|---|---|
| *ab* | with the | numerical | equivalent | | 0087 |
| *bc* | " | " | " | " | 0374 |
| *de* | " | " | " | " | 0352 |
| *bd* | " | " | " | " | 0067 |
| | | | | Making a total of | 0880 |

Turning now to the table of Figs. 3 to 7 inclusive, this total, 0880, is found about half-way down the tenth numeral column of Fig. 4: and in the two-letter group line commencing *pg*. The fourth letter of each of the two original message cipher groups are both consonants so that the two-letter checking group to be made use of in supplying the struck-out letters is *iu*, and the message cipher to be sent would therefore be *abbcidebdu*.

When a message cipher has been received, it may be decoded and checked in the reverse of the order of coding and transmittal. To see if it is correctly transmitted the fifth and tenth letters of the combination are joined in the order of receipt in the message cipher to form what is supposed to be the original two-letter checking group. The remaining letters are grouped in twos, in the order of receipt in the message cipher and their numerical equivalents from the table of Figs. 1 and 2, or a similar table, and added. The sum is located in the tables of Figs. 3 to 7 inclusive, or a similar table, and

the two-letter checking groups, of which the sum is the equivalent, referred to. If the checking group made up from the message cipher received, as just stated, is there found, the checking shows that the cablegram was correctly transmitted, and the further decoding is then proceeded with in the ordinary manner except that the fifth letter of each of the five-letter groups is not found in the message cipher: but as in the systems of codes assumed for illustration, there is always a two letter variation: this does not affect the decoding, which can readily be done from the first four letters of each five-letter group.

Obviously in the systems of codes where the four-letter groups are employed, either originally or as numerical equivalents, the two-letter variation is not necessary and the same general procedure above outlined would be employed, except that instead of replacing letters, the two-letter check group would simply be added, the first letter thereof at the end of the first four-letter group, and the second at the end of the second four-letter group.

Assuming, however, that in the cipher message desired to be sent there is an uneven number of groups so that there is an odd group of five or four letters, depending on the code system employed. The invention is applicable to that condition as can readily be understood; for instead of there being four two-letter groups for addition to ascertain the checking total, there are but two two-letter groups, and the last letter of an odd five-letter group is replaced by the checking two-letter group, or the last named group is added to an odd four-letter group in accordance with the cipher system employed.

Thus, as an illustration, assume that the entire message desired to be sent is expressed by the message cipher *abbcd*. Proceeding in the same manner as before, the numerical equivalents of the first four letters of the group are found in the table of Figs. 1 and 2 as follows:

| | | | | | |
|---|---|---|---|---|---|
| *ab* | with | the | numerical | equivalent | 0087 |
| *bc* | " | " | " | " | 0374 |
| | | | Making a total of | | 0461 |

Referring to the table of Figs. 3 to 7 inclusive, it is seen from Fig. 3 that 0461 is in the line commencing with *sk*. The fourth letter of the *abbcd* group is a consonant, and as there is no second group, the two-letter checking group can be chosen from either column 2 or column 3, and the choice should be made in favor of the pronounceability of the resultant message cipher. In this case the choice would probably be made in the third column and the message cipher combination would be *abbces*. It is not deemed necessary to illustrate the procedure where the group is originally a four-letter group. The resultant six-letter message cipher combination in either case being pronounceable, obviously can be sent for the unit word price and is inherently self-checking as before described.

Taking up now the question of an error occuring in the cipher words in transmission or otherwise. The checking proceeds in precisely the same manner outlined in regard to the correct cipher message but it will be found that instead of the numerical checking equivalents of the cipher word correctly transmitted totaling to the same sum as the numerical equivalents of the two-letter checking group, there will be a discrepancy. Obviously the error may be either in the message cipher proper or in the checking group and the problem is thus twofold: to discover, first, where the error is, and second, what the error is.

The method of procedure can probably best be understood by first giving an illustration. Assume the same example as was referred to in the preamble hereof, *i. e.*, that the message cipher *abbcidebdu* had been received as *abdcidebdu*, that is to say, that the third letter "*b*" had been received as "*d*." The total of the message cipher proper equivalents ascertained from the table of Figs. 1 and 2 as before, is obtained thus—

| | | | | | |
|---|---|---|---|---|---|
| *ab* | with | the | numerical | equivalent | 0087 |
| *dc* | " | " | " | " | 0267 |
| *de* | " | " | " | " | 0352 |
| *bd* | " | " | " | " | 0067 |
| | | | Making a total of | | 0773 |

Turning to the table of Figs. 3 to 7 inclusive, it is found that the two-letter checking group received, *iu*, does not have this numerical equivalent, but that the checking group with this numerical equivalent is either *pk iy os* or *fa*. The cipher received is therefore wrong.

Assume that the error was in the message cipher proper and that the checking group *iu* is correct. The closest *iu* value to 0773 is 0772. The total of the message cipher proper numerical equivalents, if that is the particular value of *iu* intended, is 1 in excess of the correct value. The numerical equivalent of one of the two-letter groups of the message cipher proper is probably, under that assumed value of *iu*, 0001 too high, and this 0001 should be subtracted from each of the groups successively (or until the error is found) to ascertain if the resultant two-letter group having the rectified numerical equivalent is likely to be the one in which the error occured. Thus, the correct numerical equivalent of the first two-letter group may have been 0086. Referring to the table of Fig. 8 to ascertain

what the two-letter group having this numerical equivalent is, it is found to be *ur*. To those skilled in the art, it is obvious that *ur* would rarely if ever be sent as *ab*, so that assumed error can be dismissed. Subtracting 0001 from the numerical equivalent of the second two-letter group *dc*, the result is 0266. From the table of Fig. 8, the two-letter group having the numerical equivalent 0266 is found to be *wg*, showing another improbable error. Going to the third group and subtracting the assumed error of 0001, the result is 0351. From the table of Fig. 8 the two-letter group having the numerical equivalent 0351 is found to be *wl*, another improbable error. Subtracting 0001 from the numerical equivalent of *bd*, the fourth two-letter group, and ascertaining the two-letter group having the resultant numerical equivalent 0066, it is found to be *uh*, another improbable error. Obviously, therefore, the *iu* value of 0772 is not the one intended and another value must be chosen. The new value may be conveniently chosen by taking the values successively before or successively after the "0772," and the process with the new value would be the same as above outlined. Without prolonging the illustration assume that the process had proceeded, without result, to the numerical equivalent 0880. With this equivalent the sum of the cipher message proper is found to be 0107 too small. Add the 0107 to the numerical equivalent of *ab*, 0087, and the two-letter group with the resultant numerical equivalent, 0194, is found from the table of Fig. 8 to be *rf*. To those skilled in the art, the change from *rf* to *ab* is at once seen to be improbable. Adding the 0107 to the *dc* numerical equivalent 0267, getting 0374, it is found from the table of Fig. 8 that the two-letter equivalent is *bc*. This at once appears to be the error in the message, as *bc* might quite probably have been sent as *dc*. With this assumption the cipher message correctly checks itself, and if the resultant decoded message is a likely one to be received, the error can be assumed to be discovered and corrected. As an extra precaution the process might be continued with the letters *de* and *bd*, but no likely groups would result. In the specific illustration, this is obviously unnecessary.

Assume now that the error has been in the two-letter checking group and that the message has been sent, for example as, *abbcdebdy*. The total of the message cipher groups proper is as before, 0880. Turning to the table of Figs. 3 to 7 inclusive it is found that *iy* does not have this numerical equivalent. An error is therefore discovered. The checking group to be used when the fourth letter of each five-letter group is a consonant having this numerical equivalent, is *iu*. The change from *iu* to *iy* is an error that might very probably occur, and if, with the error corrected on this assumption, the decoded message is a likely one to be received, it is fair to assume that the error has been discovered and corrected. This is found to be the case in the particular example cited.

The general rule, therefore, when the checking shows that a message cipher is incorrect, is to first endeavor to decode the message cipher proper to see if the decoded message is one likely to be received. If the error is in the message cipher proper, this would be shown at once by the decoding: either the decoding will be found to be impossible, or the decoded message will make no sense, or will be one not likely to be received. When any of these are true, it is fair to assume that the check letter group is correct. Then take various numerical equivalents of the check letter group from the table of Figs. 3 to 7 inclusive or a similar table and add or subtract, as the case may be, the difference between these individual numerical equivalents and the sum of the equivalents of the two-letter groups in the message cipher proper, to the numerical equivalents of each of the two-letter groups of the message cipher proper (or until the error has been discovered): ascertain from the table of Fig. 8 or a similar table the two-letter group of which this sum or difference is the equivalent; and continue with the process until a two-letter group has been discovered, for which the two-letter group of the erroneous message is probably the substitute. Rewrite and decode the message on this assumption. If the resultant decoded message is one likely to be received it is fair to assume that the error has been discovered. There is a possibility that the process will result in discovering more than one two-letter group which might have been sent in the erroneous message cipher received. In such a case the sense of the message and other elements later to be discussed will enable the receiver to determine which of the two-letter groups is the correct one.

If, on the other hand, the first decoding of the message results in one which was likely to be received, it is fair to assume that the error was in the checking group. In such a case, take the sum of the numerical equivalents of the two-letter cipher groups proper and ascertain what the equivalent two-letter checking group is from the tables of Figs. 3 to 7 inclusive. If this is found to be a group for which the group received could likely be substituted, it is fair to assume that the error has been discovered and that the message cipher proper is correct: if not, proceed as before outlined, on the assumption that the check letter group is correct.

It must be remembered that when codes

are adopted and made use of, the parties employing them usually do so in particular matters or lines of business and that when code messages are thus employed the receiver of the message can usually tell whether the message is one which the sender would likely send: furthermore, codes are generally worked out so that an error would result in a cipher impossible of decoding or a decoded message which would not make sense. Consequently the sense of the message is a factor upon which considerable dependence can be placed. In making use of the table of Fig. 8 or a simlar table and in endeavoring to ascertain what are the correct letters, in addition to the similarity of the letters, the pronounceability of the ten-letter group with the assumed corrected letters therein, and the question whether the second and fourth two-letter groups end with a vowel or a consonant and consequently whether the checking group would be chosen from the first, second, third or fourth columns of the table of Figs. 3 to 7 inclusive, are matters of considerable assistance, and when taken in connection with the sense of the message result in the figuring out of the correct message.

Because of the fact that the two-letter groups and the numerical equivalents in the tables of Figs. 1 and 2, and 8 are identical, either of these tables (probably the table of Fig. 8) might be dispensed with, without departing from the spirit of my invention, but dispensing with either one of these tables is not advised because of the resultant great inconvenience.

The foregoing detailed description has been given for clearness of understanding, and no undue limitation should be deduced therefrom, but the appended claims should be construed as broadly as permissible in view of the prior art.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. As a new and improved article of manufacture, a cipher-book comprising a suitable number of pages containing tables for use in coding, decoding and checking communications, one of said tables comprising in suitable arrangement groups of letters with arbitrary numerical equivalents for use in the coding and decoding of the communications, and the other of said tables comprising in suitable arrangement groups of letters with numerical equivalents for use in connection with the letters of the message cipher for the purpose of checking the coded communications, substantially as described.

2. As a new and improved article of manufacture, a cipher-book comprising a suitable number of pages containing tables for use in coding, decoding and checking communications, one of said tables comprising in suitable arrangement groups of letters, each group having arbitrary numerical equivalents for use in the coding and decoding of the communications, and the other of said tables comprising in suitable arrangement groups of letters, each group having a series of numerical equivalents for use in connection with the letters of the cipher message for the purpose of checking the coded communications, to the end that pronounceable self-checking cipher communications may be produced, substantially as described.

3. As a new and improved article of manufacture, a cipher-book comprising a suitable number of pages containing tables for use in coding, decoding and checking communications, one of said tables comprising in suitable arrangement two-letter groups, each group having an arbitrary numerical equivalent for use in the coding and decoding of the communications, and the other of said tables comprising in suitable arrangement two-letter groups, each group having a series of numerical equivalents for use in connection with the letters of the cipher message for the purpose of checking the coded communications to the end that pronounceable self-checking cipher combinations may be produced substantially as described.

4. As a new and improved article of manufacture, a cipher-book comprising a suitable number of pages containing tables for use in coding, decoding and checking communications, one of said tables comprising in alphabetical arrangement two-letter groups, each group having an arbitrary numerical equivalent for use in the coding and decoding of communications, and the other of said tables comprising in alphabetical arrangement two-letter groups, each group having a series of numerical equivalents for use in connection with the letters of the cipher message for the purpose of checking the coded communications, to the end that pronounceable self-checking cipher communications may be produced, substantially as described.

5. As a new and improved article of manufacture, a cipher-book comprising a suitable number of pages containing tables for use in coding, decoding and checking communications, one of said tables comprising in alphabetical arrangement two-letter groups, each group having an arbitrary numerical equivalent for use in the coding and decoding of the communications, and the other of said tables comprising two-letter groups arranged in four parallel columns, the groups proceeding alphabetically down the columns, the corresponding groups in each column having a series of numerical equivalents, the said groups being for use in connection with the letters of the cipher

message for the purpose of checking the coded communications, to the end that pronounceable self-checking cipher communications may be produced, substantially as described.

6. As a new and improved article of manufacture, a cipher-book comprising a suitable number of pages containing tables for use in coding, decoding and checking communications, one of said tables comprising in alphabetical arrangement in columns two-letter groups, each group having an arbitrary numerical equivalent, the said groups being for use in the coding and decoding of communications; one of said tables comprising two-letter groups arranged in four parallel columns, the groups proceeding alphabetically down the columns, the corresponding groups in each column having a series of numerical equivalents, the said groups being for use in connection with the letters of the cipher message for the purpose of checking the coded communications; and the other of said tables comprising the two-letter groups and the numerical equivalents of the first named table arranged in numerical order; to the end that pronounceable self-checking cipher communications may be produced and if the same contain errors, that the said errors may be corrected, substantially as described.

7. As a new and improved article of manufacture, a cipher-book comprising a suitable number of pages containing tables for use in coding, decoding and checking communications, one of said tables comprising in alphabetical arrangement in columns two-letter groups, each group having an arbitrary numerical equivalent, the said groups being for use in the coding and decoding of communications; one of said tables comprising two-letter groups arranged in four parallel columns, the groups proceeding alphabetically down the columns, the corresponding groups in each column having a series of numerical equivalents, the said groups being for use in connection with the letters of the cipher message for the purpose of checking the coded communications; and the other of said tables comprising in a plurality of columns the two-letter groups and the numerical equivalents of the first-named table arranged in numerical order, the numerical equivalent of each group being expressed partly above the columns of groups and partly at the side thereof, to the end that pronounceable self-checking cipher communications may be produced and if the same contain errors that the said errors may be corrected, substantially as described.

Signed at New York, in the county of New York and State of New York, this 11th day of Oct., 1916.

COSMO FARQUHAR.

**Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."**