

# RATES OF BOX AND POCKET CHRONOMETERS

ON TRIAL

FOR PURCHASE BY THE BOARD OF ADMIRALTY,

AT THE

ROYAL OBSERVATORY, GREENWICH,

BOX CHRONOMETERS—FROM 1911 JUNE 17 TO 1912 JANUARY 6.

POCKET CHRONOMETERS—FROM 1911 AUGUST 5 TO 1911 NOVEMBER 25.

## (L) WEEKLY RATES

| Order of Month | NAME of MAKER.        | No.  | Per cent. per day | June 17-24 | June 24-July 1 | July 1-8 | July 8-15 | July 15-22 | July 22-29 | July 29-Aug. 5 | Aug. 5-12 | Aug. 12-19 | Aug. 19-26 | Sept. 2-9 | Sept. 9-16 | Sept. 16-23 |
|----------------|-----------------------|------|-------------------|------------|----------------|----------|-----------|------------|------------|----------------|-----------|------------|------------|-----------|------------|-------------|
| 1              | T. Mercer             | 8306 | 2                 | -7.1       | -5.4           | -6.9     | -5.8      | -4.3       | -3.9       | -5.0           | -5.1      | -4.9       | -3.6       | -3.1      | -4.7       | -5.6        |
| 2              | V. Kullberg           | 8129 | 2                 | -1.0       | -0.2           | -0.4     | -2.1      | -1.5       | -0.1       | -0.4           | -0.2      | -1.0       | -3.7       | -4.0      | -3.7       | -2.7        |
| 3              | V. Kullberg           | 7885 | 2                 | +1.9       | +2.3           | +0.1     | -0.7      | +0.9       | +0.5       | +0.0           | -0.8      | -4.0       | -4.1       | -2.9      | -0.9       | -0.6        |
| 4              | V. Kullberg           | 8250 | 2                 | -0.7       | +0.4           | +2.0     | +0.6      | +0.5       | +0.1       | +0.7           | +0.1      | -2.0       | -1.3       | -1.7      | -0.5       | -0.5        |
| 5              | V. Kullberg           | 8258 | 2                 | +0.7       | +1.3           | +0.8     | +0.7      | +1.6       | +0.0       | -0.9           | -1.7      | -5.1       | -4.2       | -2.4      | -3.6       | -2.6        |
| 6              | A. Johannsen & Co.    | 6540 | 2                 | +1.2       | -1.1           | -4.6     | -3.3      | -4.8       | -2.1       | -2.0           | +0.8      | +2.1       | +4.2       | +3.8      | +4.9       | +0.6        |
| 7              | V. Kullberg           | 8205 | 2                 | -0.4       | -0.1           | -1.8     | -1.5      | -1.5       | -1.0       | -1.7           | -0.6      | -3.0       | -1.7       | -0.5      | -0.5       | -3.5        |
| 8              | V. Kullberg           | 8136 | 2                 | -1.1       | +0.4           | -0.2     | -1.0      | -2.2       | -1.5       | -1.0           | -0.7      | -3.0       | -1.7       | -0.5      | -0.5       | -3.5        |
| 9              | V. Kullberg           | 8142 | 2                 | +2.4       | +3.7           | +1.2     | +0.7      | +1.0       | +0.2       | +1.0           | -1.1      | +5.0       | +4.5       | +4.2      | +2.7       | +1.4        |
| 10             | V. Kullberg           | 8232 | 2                 | +0.6       | +2.6           | +2.6     | +0.6      | +2.8       | +2.1       | +2.0           | +1.0      | -1.7       | -1.0       | +2.4      | +3.4       | +5.5        |
| 11             | A. Webb               | 5692 | 2                 | -13.3      | -8.1           | -9.3     | -12.2     | -11.2      | -14.0      | -14.0          | -13.3     | -13.9      | -10.9      | -13.9     | -10.7      | -7.8        |
| 12             | V. Kullberg           | 8255 | 2                 | -3.7       | -4.1           | -5.9     | -4.8      | -4.1       | -3.6       | -4.2           | -4.1      | -7.5       | -7.7       | -7.9      | -8.1       | -8.8        |
| 13             | A. Johannsen & Co.    | 6571 | 2                 | -0.0       | -2.1           | -2.2     | -0.7      | +3.2       | +3.5       | +2.4           | +3.8      | +3.0       | +4.5       | +4.0      | +3.8       | +3.8        |
| 14             | V. Kullberg           | 8254 | 2                 | -0.1       | -0.8           | -2.1     | -0.8      | +1.4       | +2.6       | +2.4           | +4.3      | +3.0       | +5.0       | +4.2      | +0.1       | -0.8        |
| 15             | V. Kullberg           | 8259 | 2                 | -2.9       | -3.7           | -4.0     | -3.0      | -0.8       | -0.9       | -1.1           | -1.2      | -4.2       | -1.6       | -2.6      | -1.4       | -5.2        |
| 16             | Wright, Thomson & Co. | 5527 | 2                 | -0.1       | +0.7           | -1.0     | -1.8      | -2.3       | -3.8       | -1.0           | +1.1      | -4.2       | -0.8       | +2.6      | -3.5       | -0.0        |
| 17             | A. Webb               | 5706 | 2                 | -6.9       | -6.9           | -7.3     | -6.1      | -5.7       | -6.0       | -5.7           | -4.3      | -8.6       | -5.1       | -1.5      | -0.5       | -1.3        |
| 18             | A. Johannsen & Co.    | 6559 | 2                 | -0.8       | -0.4           | -3.0     | +6.4      | +7.1       | +7.4       | +7.0           | +9.2      | +10.3      | +12.2      | +12.9     | +11.7      | +8.2        |
| 19             | A. Webb               | 5710 | 2                 | -3.7       | +1.1           | -2.4     | -2.7      | -2.1       | -3.5       | -2.3           | -1.0      | -4.1       | -8.3       | +0.0      | +8.0       | +9.3        |
| 20             | A. Johannsen & Co.    | 6513 | 2                 | -4.3       | -3.7           | -4.0     | -0.9      | -1.0       | -0.6       | -1.4           | +0.1      | -0.5       | -2.7       | -6.1      | -2.1       | -3.0        |
| 21             | S. Smith & Sons       | 8007 | 2                 | -0.0       | +0.7           | -0.5     | -0.8      | +1.7       | -0.1       | -1.7           | +3.8      | +4.2       | +5.3       | +6.5      | +5.1       | +2.8        |
| 22             | A. Webb               | 5708 | 2                 | -12.5      | -11.5          | -15.0    | -16.1     | -16.9      | -16.9      | -16.8          | -12.0     | -7.0       | -3.8       | -9.1      | -12.4      | -12.6       |
| 23             | Usher & Cole          | 1855 | 2                 | +0.3       | -0.4           | -3.8     | -1.2      | -0.9       | +2.2       | +1.0           | +1.1      | -1.8       | -2.4       | +1.8      | -7.7       | +1.8        |
| 24             | A. Johannsen & Co.    | 6526 | 2                 | -3.3       | -4.3           | -6.5     | -4.0      | +1.1       | +2.2       | +3.5           | -0.4      | -1.4       | -0.8       | -0.3      | -1.2       | -2.6        |
| 25             | E. Dent & Co.         | 5552 | 2                 | +6.2       | +6.2           | +5.6     | +5.4      | +6.6       | +7.3       | +6.0           | +7.7      | +10.8      | +10.1      | +11.2     | +10.8      | +8.0        |
| 26             | A. Johannsen & Co.    | 6558 | 2                 | -1.9       | -5.2           | -2.5     | -1.9      | +4.2       | +4.3       | +3.2           | -2.6      | -3.8       | +3.4       | +4.4      | +5.6       | +1.3        |
| 27             | A. Johannsen & Co.    | 6558 | 2                 | -1.1       | -5.2           | +0.1     | +7.7      | -5.3       | -5.5       | -6.3           | -14.0     | -13.3      | -17.0      | -17.7     | -7.4       | -6.1        |
| 28             | A. Johannsen & Co.    | 6477 | 2                 | -3.8       | -6.3           | -10.7    | -10.6     | -1.2       | -2.1       | -1.5           | +2.9      | +3.5       | +5.5       | +2.9      | -1.2       | -2.5        |
| 29             | A. Johannsen & Co.    | 6555 | 2                 | -12.1      | -8.0           | -5.1     | -1.7      | -1.4       | -0.2       | -0.6           | -1.4      | -1.8       | -0.9       | -0.8      | -1.4       | -0.7        |
| 30             | Usher & Cole          | 2005 | 2                 | -2.5       | -5.2           | -6.6     | -7.4      | -2.6       | -2.2       | -3.1           | -2.4      | -6.2       | -6.5       | -0.6      | -0.9       | -0.9        |
| 31             | A. Johannsen & Co.    | 6556 | 2                 | +5.9       | +3.2           | +2.3     | +0.5      | +3.5       | +6.1       | +8.6           | +10.4     | +2.0       | -1.9       | +8.8      | +11.3      | +12.1       |
| 32             | Usher & Cole          | 2071 | 2                 | +3.9       | +3.0           | -1.2     | -1.8      | +3.2       | +3.0       | -3.4           | -0.9      | +0.8       | +1.5       | +2.8      | +0.4       | -2.5        |
| 33             | A. Johannsen & Co.    | 6570 | 2                 | -3.9       | -3.9           | -4.4     | -3.7      | -3.2       | -3.5       | -3.4           | -0.9      | +0.8       | +1.5       | +2.8      | +0.4       | -2.5        |
| 34             | A. Johannsen & Co.    | 6529 | 2                 | +1.8       | +0.2           | -1.7     | -4.3      | -1.4       | -4.6       | -4.4           | -5.4      | -4.6       | -4.4       | -4.6      | -4.4       | -4.0        |
| 35             | A. Johannsen & Co.    | 6478 | 2                 | +3.4       | +2.6           | +2.5     | +6.1      | +7.9       | +11.6      | +6.7           | +14.1     | +11.9      | +6.5       | +8.7      | +12.0      | +16.8       |
| 36             | Usher & Cole          | 2080 | 2                 | +2.4       | +3.0           | +3.9     | +4.9      | +6.9       | +8.5       | +9.6           | +12.0     | +8.4       | +13.0      | +20.5     | +21.4      | +24.4       |
| 37             | A. Johannsen & Co.    | 6581 | 2                 | +5.2       | +3.9           | +4.5     | +4.9      | +5.6       | +6.8       | +7.3           | +5.7      | +8.5       | +10.3      | +10.7     | +12.0      | +13.8       |
| 38             | A. Johannsen & Co.    | 6583 | 2                 | +3.7       | +1.8           | +0.7     | +7.8      | +11.9      | +12.9      | +12.9          | +12.9     | +12.9      | +12.9      | +12.9     | +12.9      | +12.9       |
| 39             | S. Smith & Sons       | 8011 | 2                 | -2.6       | -0.4           | -4.8     | -0.1      | +0.3       | +3.9       | +3.1           | -0.4      | -2.6       | 0.0        | +10.0     | +6.6       | +1.9        |

|                                                                              |        |        |        |        |         |         |         |         |         |         |         |         |        |        |
|------------------------------------------------------------------------------|--------|--------|--------|--------|---------|---------|---------|---------|---------|---------|---------|---------|--------|--------|
| Chronometrical Thermometer .....                                             | -492.0 | -332.4 | -718.2 | -921.5 | -1002.9 | -1361.4 | -1307.6 | -2145.2 | -3889.6 | -3600.0 | -2224.6 | -1218.8 | -811.0 | -279.0 |
| Mean Weekly Temperature .....                                                | 65.2   | 63.3   | 67.1   | 70.1   | 70.9    | 74.5    | 74.4    | 84.7    | 90.5    | 100.1   | 88.1    | 78.7    | 70.6   | 62.1   |
| Extremes of Temperature as shown by<br>the Self-Registering Thermometer. . . | 64.0   | 60.2   | 62.9   | 65.1   | 68.5    | 69.9    | 70.9    | 74.7    | 94.3    | 91.8    | 81.8    | 70.0    | 62.6   | 60.5   |
|                                                                              | 66.1   | 66.0   | 74.0   | 76.0   | 78.9    | 78.2    | 77.8    | 94.2    | 104.6   | 105.9   | 92.2    | 84.0    | 84.2   | 64.2   |

The Chronometers are placed in order of merit, their respective positions being determined by the consideration of irregularities of rate exhibited in Table II.

The sign + indicates that the rate is gaining.

+ During these weeks the Chronometers were placed in the chamber of an oven heated by jets of gas, the temperature being regulated by Kullberg's automatic gas governor which controls the supply of gas. The gas flames are exterior to the chamber, into which none of the injurious products of combustion can enter.

## IN ORDER OF TIME.

|                                       |                                       |                                       |                                       |                                       |                                |                                |                                |                                 |                                  |                                 |                                  |                                  |                                  |                                  | NAME of                                                                                              |                                      | No. |
|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--------------------------------|--------------------------------|--------------------------------|---------------------------------|----------------------------------|---------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|------------------------------------------------------------------------------------------------------|--------------------------------------|-----|
|                                       |                                       |                                       |                                       |                                       |                                |                                |                                |                                 |                                  |                                 |                                  |                                  |                                  |                                  | MAKER.                                                                                               |                                      |     |
| Sept.<br>23-30                        | Sept.<br>30-<br>Oct. 7                | Oct.<br>7-14                          | Oct.<br>14-21                         | Oct.<br>21-28                         | Oct. 28<br>to<br>Nov. 4        | Nov.<br>4-11                   | Nov.<br>11-18                  | Nov.<br>18-25                   | Nov. 25<br>to<br>Dec. 2          | Dec.<br>2-9                     | Dec.<br>9-16                     | Dec.<br>16-23                    | Dec.<br>23-30                    | Dec. 30<br>to<br>Jan. 6          |                                                                                                      |                                      |     |
| -4.4<br>-0.5<br>+1.0<br>-1.2          | -5.7<br>+1.7<br>-1.0<br>-0.6          | -5.9<br>+1.7<br>+0.9<br>-1.9          | -6.3<br>+1.7<br>-0.4<br>-1.1          | -5.0<br>+1.7<br>+0.7<br>-1.1          | -6.8<br>+1.7<br>-3.6<br>-2.7   | -4.2<br>+2.2<br>-4.1<br>-1.1   | -4.6<br>+2.2<br>-3.8<br>+1.2   | -5.4<br>+2.2<br>+3.8<br>-1.2    | -5.0<br>+2.2<br>-3.0<br>-7.7     | -5.3<br>+2.2<br>-3.5<br>-6.7    | -4.6<br>+2.2<br>-2.8<br>-6.7     | -5.2<br>+2.2<br>-1.1<br>-7.0     | -6.9<br>+2.2<br>-1.9<br>-7.5     | -6.6<br>+2.2<br>-2.5<br>-8.6     | T. Mercer<br>V. Kullberg<br>V. Kullberg<br>V. Kullberg                                               | 8306<br>8129<br>7885<br>8250         |     |
| +1.2<br>-3.7<br>+5.9<br>+5.1          | +2.9<br>-5.2<br>+2.9<br>+5.9          | +2.6<br>-5.5<br>+2.8<br>+6.9          | +0.1<br>-2.2<br>+3.2<br>+7.6          | +0.1<br>-2.2<br>+3.2<br>+7.2          | +1.5<br>-2.2<br>+3.2<br>+7.5   | +4.1<br>-1.0<br>+7.9<br>+8.8   | +3.7<br>-1.4<br>+7.2<br>+9.3   | +2.2<br>-1.4<br>+6.5<br>+10.8   | -1.2<br>-6.8<br>+5.8<br>+8.6     | -4.0<br>-7.8<br>+4.8<br>+10.3   | -1.7<br>-7.0<br>+3.1<br>+10.6    | +1.1<br>-7.6<br>+3.1<br>+11.5    | +3.1<br>-8.8<br>+3.2<br>+11.3    | -1.2<br>-8.8<br>+1.5<br>+11.4    | A. Johannsen & Co.<br>V. Kullberg<br>V. Kullberg<br>V. Kullberg                                      | 6540<br>8205<br>8136<br>8232         |     |
| -7.0<br>-11.0<br>+3.8<br>+0.5         | -6.0<br>-9.5<br>+6.8<br>-0.8          | -8.0<br>-9.3<br>+4.2<br>-10.0         | -9.0<br>-10.6<br>+3.2<br>-10.0        | -8.8<br>-10.3<br>+4.3<br>-10.0        | -10.2<br>-11.1<br>+4.3<br>-1.3 | -13.5<br>-11.0<br>+7.4<br>+2.8 | -7.4<br>-10.3<br>+8.8<br>+1.9  | -10.7<br>-15.1<br>+10.4<br>+0.3 | -10.7<br>-15.1<br>+10.4<br>-11.9 | -9.2<br>-15.1<br>+10.4<br>-12.4 | -11.6<br>-16.2<br>+10.4<br>-12.5 | -11.0<br>-16.2<br>+10.4<br>-12.5 | -13.4<br>-17.7<br>+10.4<br>-12.9 | -13.4<br>-17.7<br>+10.4<br>-12.9 | A. Webb<br>V. Kullberg<br>A. Johannsen & Co.<br>V. Kullberg                                          | 5692<br>8255<br>6571<br>8254<br>8259 |     |
| -2.0<br>+0.6<br>+8.7<br>+4.8          | -3.7<br>-1.9<br>+7.1<br>-2.6          | -1.5<br>-3.4<br>+4.9<br>-0.1          | -4.7<br>-3.0<br>+4.9<br>-2.1          | -4.8<br>-0.8<br>+12.4<br>-4.4         | -6.7<br>+1.8<br>+12.2<br>+1.3  | -1.9<br>+3.3<br>+16.3<br>-2.5  | +1.5<br>+3.8<br>+14.6<br>+3.5  | -2.9<br>+3.8<br>+10.2<br>-0.7   | -8.8<br>-6.9<br>+4.3<br>-3.8     | -6.9<br>-8.5<br>+3.9<br>-5.6    | -8.5<br>-10.3<br>+3.9<br>-6.8    | -10.3<br>-12.3<br>+3.4<br>-6.1   | -12.3<br>-15.0<br>+3.8<br>-2.5   | -15.0<br>-16.2<br>+3.8<br>-2.6   | Wright, Thomson & Co.<br>A. Webb<br>A. Johannsen & Co.<br>A. Johannsen & Co.                         | 5527<br>5706<br>6559<br>5710<br>6513 |     |
| -1.0<br>-11.3<br>+2.5<br>+4.7<br>+5.5 | -1.3<br>-12.1<br>+0.1<br>+7.1<br>+3.1 | -0.7<br>-12.9<br>-1.1<br>+4.9<br>+3.9 | -0.8<br>-13.4<br>-1.1<br>+6.6<br>+3.8 | -0.8<br>-14.1<br>-1.1<br>+6.6<br>+4.9 | -4.0<br>-15.3<br>-4.8<br>+9.8  | +7.3<br>-10.3<br>-1.4<br>+5.0  | -0.2<br>-13.4<br>+5.6<br>-3.5  | -4.8<br>-16.0<br>-1.4<br>-2.9   | -4.6<br>-16.0<br>-1.1<br>-3.5    | -4.6<br>-16.0<br>-1.1<br>-3.5   | -3.0<br>-15.1<br>-0.9<br>-2.0    | -0.9<br>-15.1<br>-0.4<br>-2.0    | -3.1<br>-13.8<br>-0.4<br>-2.9    | -3.1<br>-13.8<br>-0.4<br>-3.6    | S. Smith & Sons<br>A. Webb<br>Usher & Cole<br>Usher & Cole<br>E. Dent & Co.                          | 8007<br>5708<br>1855<br>6526<br>5552 |     |
| +1.5<br>+6.1<br>+3.0<br>-0.1          | -0.2<br>+7.1<br>+1.8<br>-2.6          | -2.0<br>+7.1<br>+2.8<br>-4.6          | -1.1<br>+4.8<br>-5.3<br>-6.1          | +4.8<br>+2.9<br>-1.9<br>-3.4          | +2.5<br>+10.3<br>-5.1<br>-4.1  | +2.5<br>+15.6<br>-0.1<br>-1.8  | +10.9<br>+12.2<br>-0.1<br>-4.6 | +5.1<br>+11.2<br>-8.0<br>-10.7  | -1.1<br>+11.0<br>-7.1<br>-10.6   | -1.1<br>+10.6<br>-10.1<br>-16.9 | -5.2<br>+5.2<br>-8.1<br>-16.9    | -1.8<br>+5.2<br>-8.1<br>-19.6    | -6.3<br>+9.8<br>-7.3<br>-14.2    | -6.3<br>+9.8<br>-7.3<br>-19.6    | A. Johannsen & Co.<br>A. Johannsen & Co.<br>A. Johannsen & Co.<br>Usher & Cole                       | 6558<br>6538<br>6570<br>2005         |     |
| +7.0<br>+5.2<br>-8.7<br>+14.6         | +1.1<br>+0.1<br>-6.0<br>-10.4         | +1.7<br>+2.4<br>-5.4<br>-7.7          | +2.9<br>+4.5<br>-9.5<br>-9.5          | +3.1<br>+4.5<br>-9.5<br>-10.0         | +3.9<br>+5.9<br>-8.7<br>+7.7   | +6.2<br>+8.4<br>-6.7<br>+6.0   | +4.6<br>+3.1<br>-1.4<br>+11.0  | -0.1<br>-8.4<br>-5.0<br>+15.5   | -1.7<br>-3.7<br>-17.4<br>+8.0    | -2.7<br>-4.9<br>-11.3<br>+9.8   | +1.4<br>-5.1<br>-10.9<br>+9.8    | -0.5<br>-5.6<br>-10.9<br>-0.8    | -1.1<br>-5.6<br>-10.9<br>-0.6    | +0.7<br>-5.6<br>-12.3<br>-15.5   | A. Johannsen & Co.<br>Usher & Cole<br>A. Johannsen & Co.<br>A. Johannsen & Co.<br>A. Johannsen & Co. | 6556<br>2071<br>6570<br>6529<br>6478 |     |
| +15.0<br>-1.0<br>-0.2                 | +9.2<br>+8.1<br>+13.6                 | +9.9<br>+4.2<br>+9.7                  | +9.0<br>+6.6<br>+6.8                  | +8.0<br>-14.9<br>+6.8                 | +11.2<br>-14.8<br>+13.0        | +12.6<br>+5.5<br>+17.5         | +12.6<br>+5.5<br>+17.5         | +12.6<br>+5.5<br>+17.5          | +9.1<br>-10.9<br>-1.8            | +10.9<br>-10.2<br>-3.7          | +8.7<br>-7.4<br>-5.9             | +9.7<br>-7.4<br>-6.4             | +10.5<br>-10.2<br>-7.4           | +7.9<br>-10.2<br>-7.4            | A. Johannsen & Co.<br>A. Johannsen & Co.<br>S. Smith & Sons                                          | 2060<br>6581<br>9311                 |     |
| -324.5                                | +185.5                                | +63.0                                 | -140.9                                | -1442.6                               | -2943.7                        | -2326.1                        | -1432.8                        | +827.4                          | +785.4                           | +688.7                          | +705.0                           | +468.3                           | +691.4                           | +504.0                           | Chronometrical Thermometer.                                                                          |                                      |     |
| 63.8                                  | 57.7                                  | 59.9                                  | 61.5                                  | 77.5                                  | 92.8                           | 91.6                           | 76.8                           | 53.1                            | 51.4                             | 52.4                            | 52.2                             | 55.0                             | 51.9                             | 54.2                             | Mean Weekly Temperature.                                                                             |                                      |     |
| 60.2                                  | 53.8                                  | 57.2                                  | 59.6                                  | 70.0                                  | 89.8                           | 83.0                           | 74.1                           | 49.5                            | 49.3                             | 50.0                            | 50.3                             | 52.9                             | 50.6                             | 52.9                             | Extremes of Temperature as shown by the Self-Register.                                               |                                      |     |
| 66.1                                  | 60.9                                  | 65.3                                  | 62.3                                  | 87.6                                  | 96.2                           | 83.3                           | 58.5                           | 44.5                            | 54.0                             | 55.0                            | 54.5                             | 55.8                             | 54.8                             | 55.5                             |                                                                                                      |                                      |     |

| Order of Merit. | NAME OF MAKER.      | No.  | Whether on or off Days. | ADDRESS OF MAKER.                             | Construction of Escapement, Balance, and Spring, from a Description furnished by the Maker. | (II.) ABSTRACT OF |                          |
|-----------------|---------------------|------|-------------------------|-----------------------------------------------|---------------------------------------------------------------------------------------------|-------------------|--------------------------|
|                 |                     |      |                         |                                               |                                                                                             | Least Weekly Sum. | Extremes of Temperature. |
| 1               | T. Mercer           | 8906 | 2                       | 81 Westmoreland Place, City Road, E.C.        | Auxiliary to balance acting in heat; palladium spring.                                      | - 7.1             | 64.0 - 66.1              |
| 2               | V. Kulberg          | 8129 | 2                       | 105 Liverpool Road, London, N.                | Kulberg's auxiliary balance; palladium spring.                                              | - 2.1             | 62.9 - 74.0              |
| 3               | V. Kulberg          | 7985 | 8                       | 105 Liverpool Road, London, N.                | Kulberg's auxiliary balance; palladium spring.                                              | - 6.2             | 52.9 - 55.5              |
| 4               | V. Kulberg          | 8250 | 2                       | 105 Liverpool Road, London, N.                | Kulberg's auxiliary balance; palladium spring.                                              | - 3.7             | 52.9 - 55.5              |
| 5               | V. Kulberg          | 8258 | 2                       | 105 Liverpool Road, London, N.                | Kulberg's auxiliary balance; palladium spring.                                              | - 8.6             | 52.9 - 55.5              |
| 6               | A. Johansen & Co.   | 6540 | 2                       | 149 Minories, London, E.                      | Auxiliary to balance acting in heat; palladium spring.                                      | - 4.8             | 65.5 - 75.9              |
| 7               | V. Kulberg          | 8205 | 2                       | 105 Liverpool Road, London, N.                | Kulberg's auxiliary balance; palladium spring.                                              | - 8.8             | 52.9 - 55.5              |
| 8               | V. Kulberg          | 8196 | 2                       | 105 Liverpool Road, London, N.                | Kulberg's auxiliary balance; palladium spring.                                              | - 1.1             | 64.0 - 66.1              |
| 9               | V. Kulberg          | 8142 | 2                       | 105 Liverpool Road, London, N.                | Kulberg's auxiliary balance; palladium spring.                                              | - 1.7             | 50.0 - 65.0              |
| 10              | V. Kulberg          | 8232 | 2                       | 105 Liverpool Road, London, N.                | Kulberg's auxiliary balance; palladium spring.                                              | - 1.7             | 94.3 - 104.6             |
| 11              | A. Webb             | 5692 | 2                       | 69 Charlton Road, Blackheath, S.E.            | Auxiliary to balance; bright steel spring.                                                  | - 14.0            | 69.9 - 78.2              |
| 12              | V. Kulberg          | 8255 | 2                       | 105 Liverpool Road, London, N.                | Kulberg's auxiliary balance; palladium spring.                                              | - 17.7            | 52.9 - 55.5              |
| 13              | A. Johansen & Co.   | 6571 | 2                       | 149 Minories, London, E.                      | Auxiliary balance acting in heat; palladium spring.                                         | - 2.2             | 62.9 - 74.0              |
| 14              | V. Kulberg          | 8254 | 2                       | 105 Liverpool Road, London, N.                | Kulberg's auxiliary balance; palladium spring.                                              | - 11.3            | 52.9 - 55.5              |
| 15              | V. Kulberg          | 8259 | 2                       | 105 Liverpool Road, London, N.                | Kulberg's auxiliary balance; palladium spring.                                              | - 13.0            | 50.3 - 64.0              |
| 16              | Whyte Thomson & Co. | 5527 | 2                       | Salter's Home Bldg., 144 Broomfield, Glasgow. | Poole's auxiliary balance acting in cold; palladium spring.                                 | - 15.0            | 52.9 - 55.5              |
| 17              | A. Webb             | 5708 | 2                       | 69 Charlton Road, Blackheath, S.E.            | Auxiliary to balance; bright steel spring.                                                  | - 8.6             | 64.3 - 104.6             |
| 18              | A. Johansen & Co.   | 6558 | 2                       | 149 Minories, London, E.                      | Auxiliary to balance acting in heat; palladium spring.                                      | - 0.8             | 64.0 - 66.1              |
| 19              | A. Webb             | 5710 | 2                       | 69 Charlton Road, Blackheath, S.E.            | Auxiliary to balance; bright steel spring.                                                  | - 7.7             | 89.8 - 98.2              |
| 20              | A. Johansen & Co.   | 6518 | 2                       | 149 Minories, London, E.                      | Auxiliary to balance acting in heat; palladium spring.                                      | - 7.9             | 52.9 - 55.5              |
| 21              | S. Smith & Sons     | 8007 | 2                       | 9 Strand, London, W.C.                        | Auxiliary to balance acting in cold; palladium spring.                                      | - 4.8             | 49.0 - 64.3              |
| 22              | A. Webb             | 5708 | 2                       | 69 Charlton Road, Blackheath, S.E.            | Auxiliary to balance; bright steel spring.                                                  | - 16.9            | 68.5 - 78.9              |
| 23              | Usher & Cole        | 1955 | 2                       | 339 St. John Street, London, E.C.             | Auxiliary to balance acting in cold; palladium spring.                                      | - 7.9             | 52.9 - 55.5              |
| 24              | A. Johansen & Co.   | 6526 | 2                       | 149 Minories, London, E.                      | Auxiliary to balance acting in heat; palladium spring.                                      | - 10.7            | 52.9 - 55.5              |
| 25              | E. Dent & Co.       | 5522 | 2                       | 61 Strand, London, W.C.                       | Plain compensation balance; palladium spring.                                               | - 8.6             | 52.9 - 55.5              |
| 26              | A. Johansen & Co.   | 6558 | 2                       | 149 Minories, London, E.                      | Auxiliary to balance acting in heat; palladium spring.                                      | - 6.3             | 52.9 - 55.5              |
| 27              | A. Johansen & Co.   | 6558 | 2                       | 149 Minories, London, E.                      | Auxiliary to balance acting in heat; palladium spring.                                      | + 0.2             | 64.0 - 66.1              |
| 28              | A. Johansen & Co.   | 6477 | 2                       | 149 Minories, London, E.                      | Auxiliary to balance acting in heat; palladium spring.                                      | - 10.7            | 62.9 - 74.0              |
| 29              | A. Johansen & Co.   | 6555 | 2                       | 149 Minories, London, E.                      | Auxiliary to balance acting in heat; palladium spring.                                      | - 12.1            | 64.0 - 66.1              |
| 30              | Usher & Cole        | 2055 | 2                       | 339 St. John Street, London, E.C.             | Auxiliary to balance acting in cold; palladium spring.                                      | - 19.6            | 52.9 - 55.5              |
| 31              | A. Johansen & Co.   | 6556 | 2                       | 149 Minories, London, E.                      | Auxiliary to balance acting in heat; palladium spring.                                      | - 2.7             | 50.0 - 55.0              |
| 32              | Usher & Cole        | 2071 | 2                       | 339 St. John Street, London, E.C.             | Auxiliary to balance acting in cold; palladium spring.                                      | - 8.4             | 49.0 - 64.3              |
| 33              | A. Johansen & Co.   | 6570 | 2                       | 149 Minories, London, E.                      | Auxiliary to balance acting in heat; palladium spring.                                      | - 17.4            | 49.0 - 64.3              |
| 34              | A. Johansen & Co.   | 6578 | 2                       | 149 Minories, London, E.                      | Auxiliary to balance acting in heat; palladium spring.                                      | - 15.5            | 52.9 - 55.5              |
| 35              | A. Johansen & Co.   | 6499 | 2                       | 149 Minories, London, E.                      | Auxiliary to balance acting in heat; palladium spring.                                      | - 4.0             | 52.9 - 55.5              |
| 36              | Usher & Cole        | 2060 | 2                       | 339 St. John Street, London, E.C.             | Auxiliary to balance acting in cold; palladium spring.                                      | + 2.4             | 64.0 - 66.1              |
| 37              | A. Johansen & Co.   | 6581 | 2                       | 149 Minories, London, E.                      | Auxiliary to balance acting in heat; palladium spring.                                      | - 10.2            | 52.9 - 55.5              |
| 38              | A. Johansen & Co.   | 6423 | 2                       | 149 Minories, London, E.                      | Plain compensation balance; palladium spring.                                               | - 7.4             | 52.9 - 55.5              |
| 39              | S. Smith & Sons     | 8011 | 2                       | 9 Strand, London, W.C.                        | Auxiliary to balance acting in cold; palladium spring.                                      | - 10.8            | 52.9 - 55.5              |

The Chronometers are placed in order of merit, their respective positions being determined by consideration of the irregularities of rate exhibited in the Table above.

The sign + indicates a gaining rate.

## THE PRINCIPAL CHANGES OF RATE DURING THE 26 WEEKS.

| Mean Temperature. | Greatest Weekly Sum. | Extremes of Temperature. | Mean Temperature. | Difference between Greatest and Least. | Greatest Difference between one Week and the next. | Mean Temperature for two Weeks. | Trial No. a + 2b. | NAME OF MAKER.      | No.  |
|-------------------|----------------------|--------------------------|-------------------|----------------------------------------|----------------------------------------------------|---------------------------------|-------------------|---------------------|------|
| (a)               | (b)                  | (c)                      | (d)               | (e)                                    | (f)                                                | (g)                             | (h)               | (i)                 | (j)  |
| 65.2              | - 2.1                | 70.0 - 84.0              | 73.7              | 5.0                                    | 2.6                                                | 73.7 - 70.6                     | 10.2              | T. Mercer           | 8906 |
| 67.1              | + 7.2                | 83.0 - 99.2              | 91.6              | 9.3                                    | 2.5                                                | 92.8 - 91.6                     | 14.3              | V. Kulberg          | 8129 |
| 64.2              | + 2.8                | 60.2 - 66.0              | 63.3              | 8.5                                    | 3.2                                                | 62.8 - 61.6                     | 14.9              | V. Kulberg          | 7985 |
| 64.2              | + 3.3                | 60.2 - 66.0              | 63.3              | 8.5                                    | 3.2                                                | 62.8 - 61.6                     | 15.3              | V. Kulberg          | 8250 |
| 64.2              | + 1.6                | 68.5 - 78.9              | 70.9              | 10.2                                   | 3.5                                                | 76.8 - 53.1                     | 17.2              | V. Kulberg          | 8258 |
| 70.9              | + 4.9                | 70.0 - 84.0              | 73.7              | 9.7                                    | 4.3                                                | 51.9 - 54.2                     | 18.3              | A. Johansen & Co.   | 6540 |
| 64.2              | + 0.5                | 81.8 - 92.2              | 88.1              | 9.3                                    | 4.6                                                | 76.8 - 53.1                     | 18.3              | V. Kulberg          | 8205 |
| 65.2              | + 9.3                | 70.0 - 84.0              | 73.7              | 9.7                                    | 4.0                                                | 77.5 - 92.8                     | 18.4              | V. Kulberg          | 8196 |
| 62.4              | + 3.7                | 60.2 - 66.0              | 63.3              | 10.8                                   | 3.9                                                | 84.7 - 99.5                     | 18.6              | V. Kulberg          | 8142 |
| 99.5              | + 11.5               | 52.9 - 55.5              | 55.0              | 13.2                                   | 8.4                                                | 100.1 - 88.1                    | 20.0              | V. Kulberg          | 8232 |
| 74.5              | - 6.0                | 53.8 - 60.9              | 57.7              | 8.0                                    | 6.1                                                | 76.8 - 53.1                     | 20.2              | A. Webb             | 5692 |
| 74.4              | - 3.6                | 52.9 - 55.5              | 55.1              | 14.1                                   | 3.4                                                | 84.7 - 99.5                     | 20.9              | V. Kulberg          | 8255 |
| 54.2              | + 10.4               | 49.5 - 55.5              | 53.1              | 15.0                                   | 5.0                                                | 53.1 - 51.4                     | 22.6              | A. Johansen & Co.   | 6571 |
| 54.2              | + 5.0                | 91.3 - 105.9             | 100.1             | 18.3                                   | 4.8                                                | 53.1 - 51.4                     | 25.9              | V. Kulberg          | 8254 |
| 52.2              | - 0.0                | 69.9 - 78.2              | 74.5              | 13.0                                   | 7.1                                                | 76.8 - 53.1                     | 27.2              | V. Kulberg          | 8259 |
| 54.2              | + 3.5                | 70.0 - 84.0              | 73.7              | 18.5                                   | 5.4                                                | 53.1 - 51.4                     | 29.3              | Whyte Thomson & Co. | 5527 |
| 99.5              | + 5.3                | 74.1 - 83.3              | 76.8              | 13.9                                   | 9.9                                                | 53.1 - 51.4                     | 29.7              | A. Webb             | 5708 |
| 65.2              | + 16.3               | 83.0 - 99.2              | 91.6              | 17.1                                   | 6.4                                                | 61.3 - 77.5                     | 29.9              | A. Johansen & Co.   | 6558 |
| 92.8              | + 3.8                | 50.6 - 54.8              | 51.9              | 11.5                                   | 7.2                                                | 76.8 - 53.1                     | 29.9              | A. Webb             | 5710 |
| 54.2              | + 5.3                | 74.1 - 83.3              | 76.8              | 13.2                                   | 8.5                                                | 53.1 - 51.4                     | 30.2              | A. Johansen & Co.   | 6518 |
| 51.4              | + 10.9               | 83.0 - 99.2              | 91.6              | 15.7                                   | 7.5                                                | 76.8 - 53.1                     | 30.7              | S. Smith & Sons     | 8007 |
| 70.9              | + 4.7                | 91.3 - 105.9             | 100.1             | 13.1                                   | 8.8                                                | 77.5 - 92.8                     | 30.7              | A. Webb             | 5708 |
| 54.2              | + 8.9                | 60.5 - 64.2              | 62.1              | 16.8                                   | 7.1                                                | 70.6 - 62.1                     | 31.0              | Usher & Cole        | 1955 |
| 54.2              | + 5.3                | 70.9 - 77.6              | 74.4              | 16.0                                   | 7.5                                                | 91.6 - 76.8                     | 31.0              | A. Johansen & Co.   | 6526 |
| 54.2              | + 11.9               | 83.0 - 99.2              | 91.6              | 15.0                                   | 8.5                                                | 76.8 - 53.1                     | 32.6              | E. Dent & Co.       | 5522 |
| 54.2              | + 10.9               | 49.5 - 55.5              | 53.1              | 17.2                                   | 7.7                                                | 100.1 - 88.1                    | 32.6              | A. Johansen & Co.   | 6558 |
| 65.2              | + 19.3               | 91.3 - 105.9             | 100.1             | 19.1                                   | 7.8                                                | 88.1 - 73.7                     | 33.7              | A. Johansen & Co.   | 6558 |
| 67.1              | + 4.7                | 49.5 - 66.0              | 53.1              | 14.1                                   | 9.4                                                | 91.6 - 76.8                     | 34.2              | A. Johansen & Co.   | 6477 |
| 65.2              | + 3.0                | 60.2 - 66.1              | 63.3              | 15.1                                   | 7.8                                                | 53.1 - 51.4                     | 34.7              | A. Johansen & Co.   | 6555 |
| 54.2              | + 0.6                | 70.0 - 84.0              | 73.7              | 20.2                                   | 7.3                                                | 52.4 - 52.2                     | 34.8              | Usher & Cole        | 2055 |
| 52.4              | + 12.1               | 62.6 - 84.2              | 70.6              | 14.8                                   | 10.7                                               | 100.1 - 88.1                    | 36.2              | A. Johansen & Co.   | 6556 |
| 51.4              | + 8.4                | 83.0 - 99.2              | 91.6              | 16.8                                   | 11.7                                               | 76.8 - 53.1                     | 39.0              | Usher & Cole        | 2071 |
| 51.4              | + 8.8                | 81.8 - 92.2              | 89.1              | 10.2                                   | 10.0                                               | 70.9 - 70.9                     | 40.0              | A. Johansen & Co.   | 6570 |
| 54.2              | + 5.2                | 94.3 - 104.6             | 99.5              | 20.7                                   | 8.8                                                | 99.5 - 100.1                    | 40.3              | A. Johansen & Co.   | 6578 |
| 54.2              | + 19.6               | 60.5 - 64.2              | 62.1              | 23.6                                   | 9.9                                                | 61.6 - 77.5                     | 41.4              | A. Johansen & Co.   | 6499 |
| 65.2              | + 24.4               | 62.6 - 84.2              | 70.6              | 22.0                                   | 11.0                                               | 70.6 - 62.1                     | 44.0              | Usher & Cole        | 2060 |
| 54.2              | + 12.8               | 60.5 - 64.2              | 62.1              | 23.6                                   | 12.0                                               | 53.1 - 51.4                     | 47.0              | A. Johansen & Co.   | 6581 |
| 54.2              | + 10.0               | 70.9 - 84.0              | 73.7              | 23.7                                   | 9.4                                                | 53.1 - 51.4                     | 47.9              | A. Johansen & Co.   | 6423 |
| 54.2              | + 10.0               | 81.8 - 92.2              | 88.1              | 28.4                                   | 10.0                                               | 100.1 - 88.1                    | 48.4              | S. Smith & Sons     | 8011 |

The Trial No. a + 2 b is taken as a measure of the irregularities of rate.

Only those Chronometers have been included in this list for which b did not exceed 12 seconds.

| Order of Merit                                                        | NAME OF MAKER.      | No.  | ADDRESS OF MAKER.              | (1) WEEKLY RATES IN |              |              |                    |              |              |              |              |                              |                                |                              |                                         |
|-----------------------------------------------------------------------|---------------------|------|--------------------------------|---------------------|--------------|--------------|--------------------|--------------|--------------|--------------|--------------|------------------------------|--------------------------------|------------------------------|-----------------------------------------|
|                                                                       |                     |      |                                | Aug. 5-12           | Aug. 12-19   | Aug. 19-26   | Aug. 26 to Sept. 2 | Sept. 2-9    | Sept. 9-16   | Sept. 16-23  | Sept. 23-27  | Sept. 27-30                  | Sept. 30 to Oct. 8             | Oct. 8-7                     | Pocket Chronometer Horizontal. Dial up. |
|                                                                       |                     |      |                                |                     |              |              |                    |              |              |              |              | Change Vertical. Pendant up. | Change Vertical. Pendant left. | Change Vertical. Pendant up. |                                         |
| 1                                                                     | Kallberg.....       | 7480 | 106 Liverpool Road, London, N. | +12.9               | +12.2        | +12.7        | +10.3              | +12.3        | +9.8         | +6.1         | +10.9        | +6.5                         | +20.8                          | +13.8                        |                                         |
| 2                                                                     | Wales & McCulloch.. | 3695 | 20 Ludgate Hill, London, E.C.  | +18.3               | +10.0        | +1.0         | +10.0              | +9.8         | +10.6        | +7.4         | -21.7        | -10.5                        | -8.4                           | -9.3                         |                                         |
| 3                                                                     | Kallberg.....       | 7457 | 106 Liverpool Road, London, N. | +10.2               | +11.0        | +10.4        | +6.2               | +8.2         | +6.0         | +13.5        | 0.0          | -3.3                         | +31.0                          | +3.5                         |                                         |
| 4                                                                     | Kallberg.....       | 7428 | 106 Liverpool Road, London, N. | +12.9               | +10.5        | +15.2        | +14.0              | +8.3         | +10.0        | +3.1         | -2.8         | +1.9                         | +2.1                           | +3.0                         |                                         |
| Mean Weekly Temperature.                                              |                     |      |                                | 74.7                | 76.4         | 71.3         | 69.4               | 78.7         | 70.6         | 85.6         | 87.7         |                              | 80.8                           |                              |                                         |
| Extremes of Temperature as shown by the Self-Registering Thermometer. |                     |      |                                | 71.0<br>79.1        | 72.7<br>79.0 | 67.3<br>75.0 | 67.1<br>71.1       | 70.0<br>84.0 | 62.8<br>84.2 | 84.6<br>86.7 | 84.8<br>86.7 |                              | 83.2<br>88.0                   |                              |                                         |

\* The weekly rates have been computed from the rates for three days.

† The weekly rates have been computed from the rates for four days.

During the period from Sept. 18 to Oct. 14, the Pocket Chronometers were placed in an oven heated by jets of gas, the temperature being regulated by Kallberg's automatic governor which controls the supply of gas. The gas flame are exterior to the chamber, into which none of the injurious products of combustion can enter.

| ORDER OF TIME.                          |               |               |                         |              |               |               | (2) ABSTRACT OF THE PRINCIPAL CHANGES OF RATE.                             |                                                                  |                         |                            |                           |                                |      | NAME<br>OF<br>MAKER. | No.  | Order of Merit. |                                      |  |  |
|-----------------------------------------|---------------|---------------|-------------------------|--------------|---------------|---------------|----------------------------------------------------------------------------|------------------------------------------------------------------|-------------------------|----------------------------|---------------------------|--------------------------------|------|----------------------|------|-----------------|--------------------------------------|--|--|
| Oct.<br>7-14                            | Oct.<br>14-21 | Oct.<br>21-28 | Oct. 28<br>to<br>Nov. 4 | Nov.<br>4-11 | Nov.<br>11-18 | Nov.<br>18-25 | Difference of Weekly Rates.                                                |                                                                  |                         |                            |                           | Trial<br>Number.               |      |                      |      |                 |                                      |  |  |
| Pocket Chronometer Horizontal. Dial up. |               |               |                         |              |               |               | Difference between pendant<br>and least Weekly Rate.<br>Dial up.           | Greater difference between<br>one week and the next.<br>Dial up. | Pendant up<br>-Dial up. | Pendant right<br>-Dial up. | Pendant left<br>-Dial up. | $a+2b$<br>$1(c+\frac{d+e}{2})$ |      |                      |      |                 |                                      |  |  |
|                                         |               |               |                         |              |               |               | a.                                                                         | b.                                                               | c.                      | d.                         | e.                        |                                |      |                      |      |                 |                                      |  |  |
| + 4.1                                   | + 5.8         | + 8.6         | + 6.8                   | + 6.8        | + 6.2         | + 3.8         | 9.1                                                                        | 3.8                                                              | + 7.3                   | + 1.4                      | +15.7                     | 15.7                           | 22.3 | Kullberg.....        | 7460 | 1               |                                      |  |  |
| + 8.9                                   | + 6.9         | + 7.8         | + 8.1                   | + 7.6        | + 5.7         | +10.6         | 12.3                                                                       | 9.0                                                              | -23.7                   | -18.7                      | -16.6                     | 80.3                           | 48.1 | Wales & McCulloch..  | 3695 | 2               |                                      |  |  |
| +12.5                                   | + 2.1         | + 1.0         | - 2.8                   | - 3.8        | - 4.5         | - 6.3         | 19.8                                                                       | 10.4                                                             | -11.2                   | -16.8                      | +18.0                     | 40.6                           | 51.9 | Kullberg.....        | 7457 | 3               |                                      |  |  |
| + 6.1                                   | +17.2         | +29.1         | +29.3                   | +38.9        | +29.1         | +35.8         | 32.7                                                                       | 11.9                                                             | - 4.5                   | - 2.7                      | - 2.5                     | 56.5                           | 59.7 | Kullberg.....        | 7428 | 4               |                                      |  |  |
| 88.4                                    | 61.5          | 59.2          | 57.0                    | 56.8         | 55.4          | 53.1          | Mean Weekly Temperature.                                                   |                                                                  |                         |                            |                           |                                |      |                      |      |                 | The sign + indicates a gaining rate. |  |  |
| 85.9                                    | 59.6          | 54.1          | 54.9                    | 53.8         | 53.7          | 49.5          | { Extremes of Temperature as shown by the<br>Self-Registering Thermometer. |                                                                  |                         |                            |                           |                                |      |                      |      |                 |                                      |  |  |
| 90.2                                    | 63.3          | 64.1          | 62.1                    | 59.8         | 57.7          | 58.5          |                                                                            |                                                                  |                         |                            |                           |                                |      |                      |      |                 |                                      |  |  |

The quantities  $a, b, c, d, e$ , in the formulae  $a + b + \frac{1}{2}(c + \frac{d+e}{2})$  are taken numerically without regard to sign.