

BELL SYSTEM PRACTICES  
Teletypewriter and Manual  
Telegraph Station and PBX  
Installation and Maintenance

SECTION P31.910  
Issue B, 3-23-51  
Long Lines Department  
Dist. Class. 600AC

## GILL SELECTOR AUTOMATIC CALLING KEY

### 1. GENERAL

1.00 This section is reissued to combine the information formerly contained in Issue A of Section P31.910 and Issue A of the Addendum. Additional information on testing the calling key is furnished in this issue.

1.01 This section describes the telegraph type Gill selector automatic calling key, specifies its mechanical requirements and adjusting procedures, and furnishes information on and procedures for testing the calling key to determine whether or not it is in satisfactory adjustment.

### 2. DESCRIPTION

2.01 The Gill selector automatic calling key is a device having a spring driven gear train that is adapted to rotate a wheel at a uniform speed. This wheel, known as the combination wheel, has notches or teeth cut in its periphery, which open and close a contact to send impulses of long and short duration in accordance with a predetermined combination. The wheel has in addition to the combination notches, a series of notches, (usually six or one more than the largest digit in any combination) which send preliminary clearing out impulses.

2.02 A retaining arm, fastened by two set screws to the starting handle shaft, engages a stop pin in the combination wheel and restrains it against the action of the driving spring. A clockwise one-fifth turn of the starting handle releases the combination wheel which makes one revolution

and is again restrained by the retaining arm. During the revolution of the combination wheel all the selectors on the circuit are cleared out and set at their starting positions, and those selectors which are arranged for the combination corresponding to that of the operated calling key are stepped to their closed contact positions, held for a period, and then released.

### 3. APPARATUS REQUIREMENTS AND ADJUSTING PROCEDURES

#### 3.001 Tools and Gauges

<u>Code No.</u>	<u>Description</u>
-	3-1/2" Cabinet Screwdriver
-	4" Regular Screwdriver
KS-6015	Duck-bill Pliers
66-D	Thickness Gauge Nest
R-1575	No.4 Artists' Show Card Brush
D-98063	Cleaning Cloth or .
KS-2423	Cloth
KS-6232	Oil
KS-8372	Trichlorethylene
KS-7860	Mineral Spirits
	Toothpicks, Hardwood, Flat at one End and Pointed at Other
	Small Flat Piece of Wood

#### 3.01 Cleaning

- (1) Clean the contacts as prescribed in Section B503.605.
- (2) Thoroughly clean all bearings of the gear train and escapement, including the pallet points, by flushing them with KS-7860 Mineral Spirits applied with a toothpick. Operate the key and reflush.
- (3) Remove the mineral spirits and all the old oil from the parts with a clean D-98063 cleaning cloth or KS-2423 cloth wrapped around a flat piece of wood.

- (4) Allow the parts to dry and then lubricate as outlined in 3.02.

### 3.02 Lubrication

Lubricate all bearings of the gear train and escapement with KS-6232 oil applied with the R-1575 brush. Two dips of oil are sufficient for application to four or five points.

Note: One dip of oil is the amount of oil retained on R-1575 brush after being dipped into the oil to a depth of  $3/8$ " and then scraped on the edge of the container to remove the surplus oil. There should not be sufficient oil adhering to the brush to form one drop on the end of the bristles.

### 3.03 Freedom of Movement

- (a) All moving parts shall be free from bind. Gauge by feel.
- (b) All shafts shall have a minimum end play of .003 inch.
- (c) There shall be a minimum clearance of .003 inch between the combination wheel hub and the gear train frame when the shaft is at the opposite end of its travel. In adjusting the position of the combination wheel on its shaft, hold escapement ratchet and use  $3-1/2$ " cabinet screwdriver to turn set screw.
- (d) There shall be a minimum clearance of .005 inch between the retaining arm and the combination wheel when these parts are in the closest proximity that the end play of their shafts will permit. In adjusting position of retaining arm on its shaft, use  $3-1/2$ " cabinet screwdriver to turn the set screws, and set the retaining arm so that the combination wheel stop pin engages the retaining arm at the apex of the angle at the crooked end.

(e) The escapement ratchet tail shall be free to vibrate without striking any other part of the key. If, to meet this requirement, it is necessary to bend the tail, duck-bill pliers may be used, but care must be taken not to unduly strain the shaft bearings.

### 3.04 Operating Time

(a) The operating time of the key, that is, the period during which, after the key is fully wound and then released, the key mechanism operates and then comes to a normal stop, is approximately 15 seconds. During this time, the combination wheel should make one complete revolution. The operating time shall be longer than 14 seconds but not longer than 16 seconds, which requirement shall be met for any position in which the key may be placed. Gauge by second hand of watch or preferably by a stop watch if one is available.

(b) If key is too fast, loosen retaining arm set screws with 3-1/2" cabinet screwdriver, rotate retaining arm clockwise and hold it against retaining arm stud. When the combination wheel has made at least 1-1/2 revolutions, rotate the retaining arm into place to engage the combination wheel stop pin. See that the arm is placed in accordance with 3.03 (d) and tighten set screws. Check the operating time. Repeat this process until operating time requirements are met.

(c) If key is too slow, loosen retaining arm as in 3.04 (b). Hold escapement ratchet and wind driving spring by turning starting handle in clockwise direction, being careful not to overwind the spring. Rotate the retaining arm into place to engage the combination wheel stop pin and release the escapement ratchet. Then proceed as in 3.04 (b).

### 3.05 Contact Separation

The contact separation shall be a minimum of .035 inch. Use 66-D gage.

### 3.06 Contact Follow

There shall be a perceptible following movement of the back spring as the actuating spring moves away from it. Gauge by eye while key is operating.

### 3.07 Contact Timing

(a) Contacts shall remain closed during a minimum of 10 strokes of one of the escapement ratchet pallet points and shall remain open during a minimum of 13 strokes. A pallet point stroke is the movement of a pallet point either toward or away from the escapement wheel. Gauge by eye while rocking the escapement ratchet back and forth, using the six clearing out notches to operate the contact springs. This can be conveniently done as follows:

With the loop in the end of a straightened out No.2 Bell System paper clip hooked over the escapement ratchet tail, hold the escapement and operate the starting lever. Rock the ratchet back and forth by means of the paper clip until the contacts open. Then while rocking the ratchet, count the strokes both forward and back and note the number required to close the contacts (Min.=13) and the number required to open it again (Min.=10). Repeat until all six of the clearing out notches have passed the actuating spring brush.

(b) If this requirement is not met loosen slightly the two contact spring assembly bracket mounting screws with a 4" regular screwdriver and rotate the spring assembly away from the combination wheel. See that both springs are straight and that the actuating spring brush is set at an angle of approximately 45° from the actuating spring. Gauge by eye. Set contact springs to provide a .040 contact separation. Use 66-D gauge. Make required spring adjustments with duck-bill pliers. Rotate contact spring assembly clockwise so that actuating spring brush bears on the combination wheel and closes contacts with sufficient pressure to cause a very slight bending of the actuating spring, and

tighten the two contact spring assembly bracket screws. If further adjustment is required to meet the contact timing requirements it should be made by bending only the back contact spring. When the contact timing requirements have been met, see that the contact separation and follow requirements are still met.

#### 4. OPERATION TESTS

4.01 The following paragraphs describe operation tests specified for service requirements, which should be used as a check after the key has been adjusted for apparatus requirements or at any time when the key is suspected of being in trouble.

##### 4.02 Time of Operation

At the office making the check, connect a sounder in the circuit with the Gill calling key, and have the key under test operated. measure accurately with a watch, the period of time in seconds between the first opening and the last closing of the sounder. If this period is not between 14 and 16 seconds the key is out of adjustment. Next have the key under test operated several times in succession and by listening to the sounder determine the code sent by the key. Compare the code read from the sounder with the code assigned to the key under test. It is important that the first series of impulses sent by the key be one greater than the highest digit used in any code assigned to any station on the circuit. Also all codes must end with the digit 1.

##### 4.03 Testing the Adjustment of the Gill Key Contacts with a Teletypewriter Arranged to Print on Letters and Blank.

Connect a 60 or 75 speed synchronous motor teletypewriter, having its range finder at optimum setting, in the circuit with the calling key under test. Operate the calling key three times in succession, advancing the paper in the teletypewriter manually several line feeds (or

spaces in the case of No. 14 machines) between each key operation. The characters (or functions) a teletypewriter in proper adjustment and free from manufacturing deviations should print under ideal conditions when spacing signals of various lengths are received are shown in the Tables 1, 3 and 5 and Exhibits 1 and 4.

4.04 According to Section AB95.102 the selecting mechanism of the receiving teletypewriter is so arranged that it can be influenced only momentarily during the central portion of a perfect signal. Due to mechanical irregularities however, the instant of selection varies over about 20% of a unit and at 60 speed this interval is approximately 4.4 milli-seconds. However, for the purpose of illustration, in Table 1 "Measuring Length of Received Spacing Pulse" we have used the center of each unit as the reference point for determining symbol likely to be printed. Referring to the 60 speed column in Table 1, Note 1 should a series of "V's" and an occasional "M" be received, it would indicate that the length of most of the spacing pulses is not quite 198 milliseconds while should the pattern be reversed and a series of "M's" and an occasional "V" be received, it would indicate that most of the spacing pulses are somewhat greater than 198 milliseconds.

4.05 Testing the Adjustment of the Gill Key Contacts with a Teletypewriter Not Arranged to Print on Letters and Blank.

With a 60 or 75 speed synchronous Motor Teletypewriter having its range finder set for optimum tolerance in the circuit with the calling key, have the calling key operated three times in succession, advancing the paper in the teletypewriter several line feeds or spaces between each key operation. The characters a teletypewriter should print during the operation of the key are indicated in Tables 1, 2 and 4 and Exhibits 2 and 3. Normally the space to mark transition occurs during the second revolution of the receiving teletypewriter mechanism and as the receiving cam completes the

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first revolution, the typing unit goes through a cycle of operation. On all machines this latter operation is audible and on page machines the ribbon mechanism oscillates once. It therefore is feasible to determine the number of operations of the typing unit during each spacing pulse.

#### 4.06 60 Speed Teletypewriter.

For a key in proper adjustment, a series of "V's", "M's" or "V's" and "M's" totalling seven more than the sum of the digits of the code will be printed on the second revolution as illustrated in Exhibit 2. For example, the number of letters printed from Code 52521 should be  $15 + 7$ , or 22. If a number of "O's" or "T's" are received and the operation of the typing unit indicates the character is printed on the first revolution the contacts are too close. If these characters are printed on the second revolution the contacts are too wide.

If "V's" and an occasional "LTRS" combination are received the contacts are too close if the character is printed on first revolution and too wide if printed on the third revolution. Since the "LTRS" combination does not print, its occurrence will be indicated by the total characters that are printed being less than the sum of the pulses in the code plus seven.

#### 4.07 75 Speed Teletypewriter.

For a key in proper adjustment, a series of "O's", "T's" or "O's" and "T's" totalling seven more than the sum of the digits will be printed on the second revolution as illustrated in Exhibit 3. If the printing occurs on the first revolution the contacts are too close. If the series consists of "M's" and "V's" and the printing occurs on the second revolution the contacts are also too close.



TABLE 1

MEASURING LENGTH OF RECEIVED SPACING PULSE

<u>Character Printed By Teletypewriter</u>	Length of received spacing signal in Milliseconds which will produce the characters indicated in the column at left			
	<u>60-Speed</u>		<u>75-Speed</u>	
Letters	1	33	1	26.4
V	33	55	26.4	44
M	55	77	44	61.6
O	77	99	61.6	79.2
T	99	121	79.2	96.8
Blank	121	143	96.8	114.4
Blank and Letters	143	176	114.4	140.4
Blank and V	176	198	140.4	158
Blank and M	198	220	158	175.6
Blank and O	220	242	175.6	193.2
Blank and T	242	264	193.2	210.8
Blank and Blank	264	286	210.8	228.4
Blank, Blank and Letters	286	313	228.4	254.4
Blank, Blank and V	313	335	254.4	272
Blank, Blank and M	335	357	272	289.6

Note 1 - Receipt of these characters (Blank and V, Blank and M or Blank with combinations of V and M) on a 60 speed teletypewriter for each open sent by the Gill calling key, indicates that the key is sending properly timed signals.

Note 2 - Receipt of these characters (Blank and O, Blank and T or Blank with combinations of O and T) on a 75 speed teletypewriter for each open sent by the Gill calling key, indicates that the key is sending properly timed signals.

Note 3 - The optimum open or spacing signal sent by the Gill calling key is 183 Milliseconds.

Note 4 - For teletypewriters printing symbols and characters the number printed should be twice the sum of the digits in the code, the clearing out

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and release pulses. As the clearing out pulses normally total one pulse higher than the largest digit in the code, the number printed for Code 52521 would be 44. Example:  $(6+5+2+5+2+1+1) \times 2 = 44$ .

Note 5 - For teletypewriter printing only characters, the number printed would be the sum of the digits in the code plus the clearing out and release pulses. As the clearing out pulses normally total one pulse higher than the largest digit in the code, the number printed for Code 52521 would be 22. Example:  $6+5+2+5+2+1+1 = 22$ .

TABLE 2

60 SPEED - TELETYPEWRITER

DOES NOT PRINT ON LTRS AND BLANKS

<u>Character Printed</u>	<u>Number of Revolutions</u>	<u>Condition</u>
T	1	Contacts too close
-	1	Contacts too close
-	2	Contacts too close
V	2	Contacts OK
M	2	Contacts OK
V-M	2	Contacts OK
O	2	Contacts too wide
T	2	Contacts too wide

Note 1 - The presence of any other character besides those listed in the first column indicates interference of some kind during tests.

TABLE 3

60 SPEED - TELETYPEWRITER PRINTS

ON LTRS AND BLANKS

<u>Character Printed</u>	<u>Symbol Printed</u>	<u>Number of Revolutions</u>	<u>Condition</u>
T	-	1	Contacts too close
-	Blank	1	Contacts too close
-	Blank LRTS	2	Contacts too close
V	Blank	2	Contacts OK
M	Blank	2	Contacts OK
V-M	Blank	2	Contacts OK
O	Blank	2	Contacts too wide
T	Blank	2	Contacts too wide

Note 1 - The presence of any other character besides those listed in the first column indicates interference of some kind during tests.

TABLE 4

75 SPEED - TELETYPEWRITER DOES

NOT PRINT ON LTRS AND BLANK

<u>Character Printed</u>	<u>Number of Revolutions</u>	<u>Condition</u>
T	1	Contacts too close
-	1	Contacts too close
-	2	Contacts too close
V	2	Contacts too close
M	2	Contacts too close
O	2	Contacts OK
T	2	Contacts OK
O-T	2	Contacts OK
-	2	Note 1

Note 1 - The presence of any other character besides those listed in the first column indicates interference of some kind during tests.

TABLE 575 SPEED - TELETYPEWRITER PRINTSON LTRS AND BLANKS

<u>Character Printed</u>	<u>Symbol Printed</u>	<u>Number of Revolutions</u>	<u>Condition</u>
T	-	1	Contacts too close
-	Blank	1	Contacts too close
-	Blank-LTRS	2	Contacts too close
V	Blank	2	Contacts too close
M	Blank	2	Contacts too close
O	Blank	2	Contacts OK
T	Blank	2	Contacts OK
O-T	Blank	2	Contacts OK
-	Blank-Blank	2	Contacts too wide
-	Blank-Blank-LTRS	3	Contacts too wide

Note 1 - The presence of any other character besides those listed in the first column indicates interference of some kind during tests.



EXHIBIT 2

OBSERVATIONS WITH 60 SPEED TELETYPEWRITER WITHOUT BLANK

AND LTRS SYMBOLS

CODE 52521

CLEAR OUT  
PULSES

RELEASE  
PULSE

6 5 2 5 2 1 1  
VVVVVVVVVVVVVVVVVVVVVVVV

SATISFACTORY

6 5 2 5 2 1 1  
MMMMMMMMMMMMMMMMMMMMMMMM

SATISFACTORY

6 5 2 5 2 1 1  
VVVMMVMMVVMVVMMMVMVMM

SATISFACTORY

NOTE- THE PRESENCE OF A CHARACTER OTHER THAN V, M, O OR T  
INDICATES A MOMENTARY HIT DURING DIALING.

EXHIBIT 3

OBSERVATIONS WITH 75 SPEED TELETYPEWRITER WITHOUT BLANK

AND LTRS SYMBOLS

CODE 52521

CLEAR OUT  
PULSES

RELEASE  
PULSE

6 5 2 5 2 1 1  
TTTTTTTTTTTTTTTTTTTTTTTTTTTT

SATISFACTORY

6 5 2 5 2 1 1  
OOOOOOOOOOOOOOOOOOOOOOOO

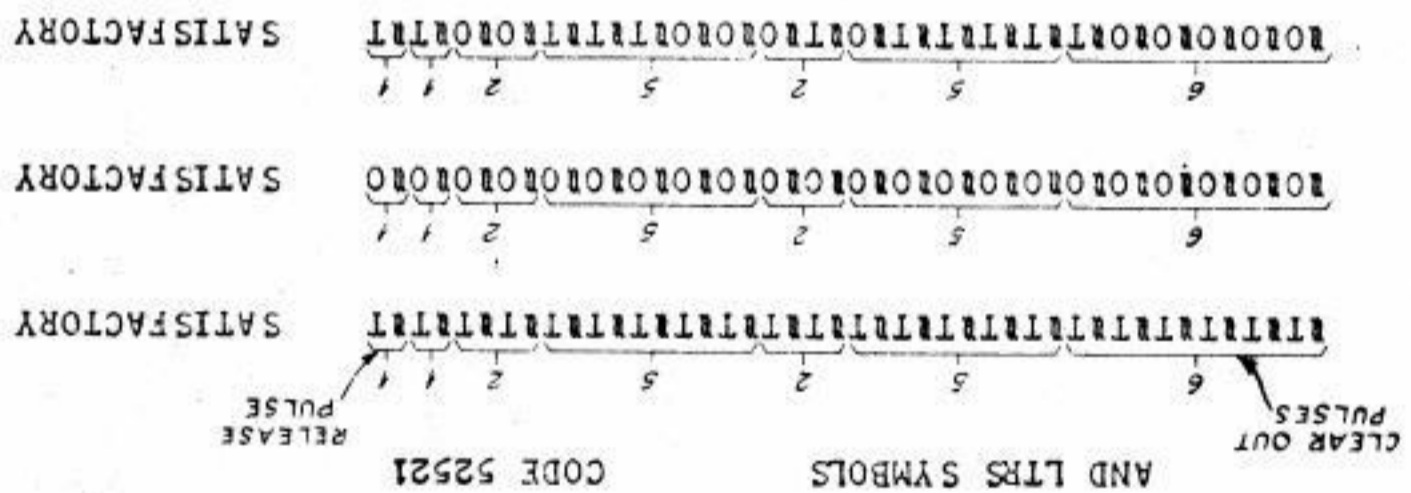
SATISFACTORY

6 5 2 5 2 1 1  
OOOTTOTTTOOTOOOOTTTOOOTT

SATISFACTORY

NOTE- THE PRESENCE OF A CHARACTER OTHER THAN V, M, O OR T  
INDICATES A MOMENTARY HIT DURING DIALING.

NOTE- THE PRESENCE OF A CHARACTER OTHER THAN V, M, O OR I  
INDICATES A MOMENTARY HIT DURING DIALING.



OBSERVATIONS WITH 75 SPEED TELETYPEWRITER HAVING BLANK

EXHIBIT 4