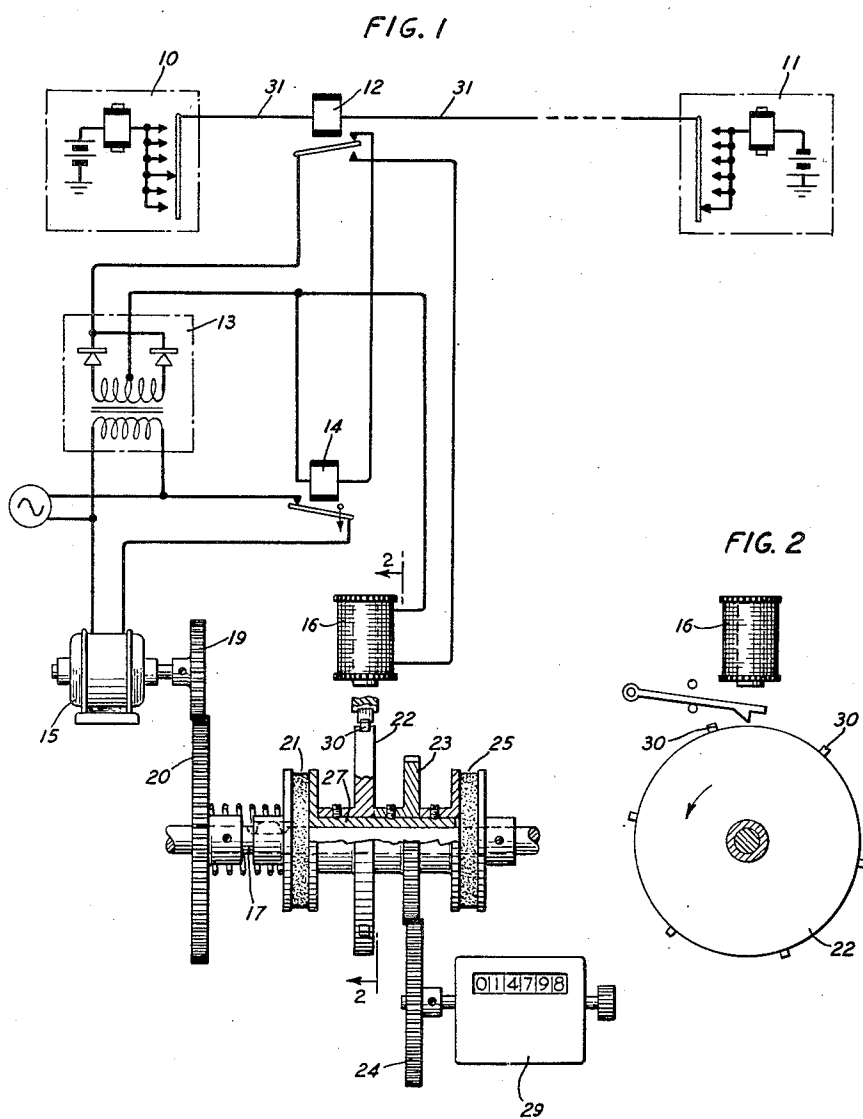


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W. Y. LANG
COUNTING APPARATUS
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INVENTOR
W. Y. LANG
BY *J. H. Schmid*
ATTORNEY

UNITED STATES PATENT OFFICE

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COUNTING APPARATUS

Wilmarth Y. Lang, Towaco, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

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This invention pertains to counting apparatus, and more particularly to word or character counting apparatus which may be connected to an electrical conductor over which a start-stop signaling code comprising various combination of current and no-current intervals is transmitted.

The usual means for counting the words or characters transmitted by a teletypewriter station utilizes a mechanical connection to the teletypewriter keyboard or tape transmitter, or utilizes apparatus which indicates the elapsed time of operation as a representation of the number of words or characters transmitted. The latter method is not suitable for use with a teletypewriter station which is keyboard operated since the code representations generated by such a station are not transmitted at a constant rate. The former method is often subject to mechanical failures and is restricted to use with one teletypewriter keyboard or tape transmitter at a time.

An object of this invention is to provide a word counting apparatus which may be connected to any part of a line interconnecting teletypewriter stations and which will indicate an accurate count for signals generated by either keyboard or tape transmitter operation.

The invention features an arrangement in which each transmitted character code combination causes an incremental advancement of the counting apparatus, and the count is registered directly as a totalization of words of standard or average length.

Other objects and advantages of the invention will be apparent from a consideration of the following description, the appended claims, and the drawings, in which:

Fig. 1 indicates the mechanical and electrical features of the counter; and

Fig. 2 is a sectional view of the escapement apparatus.

The apparatus disclosed in Fig. 1 is designed for use in conjunction with an electrical conductor over which a start-stop, five-unit signaling code is transmitted, wherein the code consists of five impulses, each of which may be a marking (current) impulse or a spacing (no current) impulse. Each group of five signaling impulses is preceded by a start signal (a spacing impulse) and followed by a stop signal (a marking impulse) which may be of the same duration as the code impulse signals or of slightly greater duration than the code impulse signals and serve to maintain synchronism between all stations interconnected by the same line. When no code signals are being transmitted through the interconnecting line an idle condition marking current, comprising a steady current, is normally passed through the line, and the line is normally never in a total spacing (i.e., current off) condition, except when the system is completely shut down or the circuit is unintentionally broken due to a trouble condition, or the circuit is intentionally broken by an operator at

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a receiving station so as to notify an operator at the sending station that the code signals are not being received properly or that the receiving station has an urgent message to be transmitted which should take precedence over the message then being transmitted. Reference may be made to Patent 1,904,164 issued to Sterling Morton et al. on April 18, 1933, for a disclosure of a teletypewriter station which fulfills the foregoing conditions and utilizes a keyboard transmitter, and the disclosure of the Morton patent is incorporated herein by reference as part of the present specification. It is to be understood that the counting apparatus disclosed herein may be used along a line conducting any type of electrical code signals provided each group of code signals which represents a character is preceded by a certain electrical condition and is followed by a different electrical condition.

The disclosure of the mechanical and electrical features of the counting apparatus in Fig. 1 indicates that the registering mechanism is operated by a constant speed electrical motor through mechanical interconnecting means and that both the motor and the interconnecting means are under the control of electrical apparatus which is connected to an electrical conductor interconnecting two teletypewriter stations such as the type disclosed in Patent 1,904,164.

The counting apparatus disclosed in Fig. 1 is controlled by a relay 12 having its winding connected in series with the telegraph line 31. Relay 12 is preferably of a low impedance type so as not to modify the electrical characteristics of line 31 to the extent that the transmission of code signals from one station to another would be interfered with. Also, relay 12 should be of a design that will respond to the rapid changes in line current produced by the code signals. The armature of relay 12 is operated while the idle condition marking current is being passed through the line, and when the start signal is transmitted over the line, the armature releases and thereafter operates and releases in accordance with the code signals transmitted over the line. The stop signal causes the armature to operate again, thereby preparing the apparatus for the next code signal.

The front contact of relay 12 is connected to the winding of relay 14 which is a slow-releasing type, and the back contact of relay 12 is connected to the winding of electromagnet 16. The direct current output of the rectifier 13, the input of which is connected to a source of alternating current, is connectable to the windings of relay 14 and electromagnet 16 through the armature of relay 12, from which it follows that current is allowed to flow through the armature of relay 12 to the winding of relay 14 during each marking impulse or signal and to the winding of electromagnet 16 during each spacing impulse or signal.

Relay 14 is designed so that its armature is not released unless the flow of current to the relay

winding is interrupted for a certain length of time which exceeds the maximum time during which successive spacing signals and impulses are ordinarily sent over line 31. For the five-unit code commonly used in teletypewriter circuits this maximum time consists of the time required for the start signal and the total time required for the five signaling impulses. Thus, the armature of relay 14 remains operated at all times unless line 31 is not energized for a time exceeding the maximum time during which continuous spacing signals and impulses are normally sent over the line. Constant speed motor 15 is energized through the armature and front contact of relay 14, and as stated hereinbefore, line 31 remains in a spacing condition for an interval of time exceeding the code signal intervals and releases relay 14 only when the line circuit is unintentionally broken due to a trouble condition or when the circuit is intentionally broken by an operator. Since these two situations seldom occur under normal operating conditions, motor 15 is normally operated continuously.

Electromagnet 16 is designed so that instantaneous operation or release of its armature is obtained when its winding is energized or de-energized depending upon the condition of relay 12. Thus, the armature of electromagnet 16 is released while marking signals or impulses are being transmitted over line 31 and the armature is operated while spacing signals or impulses are being transmitted. The armature of electromagnet 16 serves as a controlling means in an escapement mechanism which will be described hereinafter.

Motor 15 is coupled to shaft 17 through gears 19 and 20, and the speed of the motor and the gear ratio are proportioned so that shaft 17 rotates at one-sixth the speed of the receiving shaft of the teletypewriter stations. Shaft 17 is coupled to shaft 27 through friction clutches 21 and 25. Escapement wheel 22 is attached to shaft 27 in a position so that its movement is under the control of the armature of electromagnet 16, and gears 23 and 24 couple shaft 27 to rotation counter 29 so that the rotation counter registers one count for each revolution of shaft 27. Rotation counter 29 may be any apparatus adapted to be coupled to a shaft and adapted to indicate the cumulative number of revolutions which the shaft makes.

The escapement wheel is provided with six protrusions evenly spaced around the periphery of the wheel and positioned so as to engage with the armature of electromagnet 16 when the armature is in a released condition. Thus, escapement wheel 22 and shaft 27 are not allowed to rotate while the armature of electromagnet 16 is engaged with one of the protrusions on the escapement wheel, and when this condition prevails friction clutches 21 and 25 permit continuing rotation of shaft 17. The protrusions on the escapement wheel are spaced so that the operating time for each escape cycle is substantially equal to the time required for a start-stop permutation code signal combination.

While the idle condition marking current is being transmitted through line 31, the armature of relay 12 is operated, the armature of relay 14 is operated and the armature of electromagnet 16 is released. Therefore, motor 15 and shaft 17 will revolve continuously, but shaft 27 is not allowed to revolve and actuate revolution counter 29 since the armature of electromagnet 16 is engaged with one of the protrusions on escapement wheel 22.

When the first start signal is transmitted over the line, the armature of relay 12 releases, thereby interrupting the flow of current to the winding of relay 14 and energizing the winding of electromagnet 16. Since relay 14 is a slow-releasing type, its armature remains operated and the flow of current to motor 15 is not interrupted. However, the armature of electromagnet 16 operates and disengages from the protrusion of escapement wheel 22, thereby permitting the escapement wheel and shaft 27 to rotate under the influence of the rotation of shaft 17 as applied through clutch 21. While the spacing and marking impulses representing the first code character are transmitted over line 31, the armature of relay 14 remains operated and the armature of electromagnet 16 responds to the impulses by operating during spacing impulses and releasing during marking impulses. Since the periphery of the escapement wheel between adjacent protrusions contains no irregularities which could engage with the released armature of electromagnet 16 and since the time required for the transmission of a start signal and the code impulses and a portion of the stop signal equals the time required for the escapement wheel to make one-sixth of a revolution, it is apparent that the rotation of escapement wheel 22 is not interrupted during the time required for the transmission of the code combination. However, when the stop signal is transmitted over line 31, the armature of electromagnet 16 is released and the armature is in position at this time to engage a protrusion on the escapement wheel, thereby stopping rotation of the escapement wheel after it has rotated one-sixth of a revolution. Since there are six protrusions evenly spaced around the periphery of the escapement wheel and since the escapement wheel rotates at one-sixth the speed of the receiving shafts of the teletypewriter stations, a protrusion is always moving into a position to engage with the armature of electromagnet 16 when a stop signal is transmitted over line 31.

The receiving shafts of teletypewriter stations such as disclosed in Patent 1,904,164 are ordinarily rotated at a speed which permits the receiving mechanism to assume a brief idle condition after each code combination is registered. Since the shafts of the word counter herein disclosed rotate at a speed which is a fixed proportion of the speed of the receiving shafts of the teletypewriter stations, the mechanism of the word counter will also assume a brief idle condition after each code combination actuates the escapement mechanism.

Thus, it is apparent that the escapement wheel is permitted to revolve one-sixth of a revolution during the transmission of each code combination over the line and that the start signal which precedes each code combination serves to cause the escapement wheel to be released and that the stop signal which succeeds each code combination serves to cause the escapement wheel to be stopped. Also, it is apparent that the escapement wheel will not be allowed to rotate while an idle condition marking current is being transmitted over the line.

As illustrated in Fig. 1, teletypewriter station 10 is transmitting code signals and station 11 is receiving the signals. The transmitter is generating a marking impulse representing the second impulse of the five-unit code, so the armature of relay 12 is operated and the armature of electromagnet 16 is released. Fig. 2 indicates

the condition of the escapement mechanism at a time corresponding to the end of the second code impulse. During the third, fourth and fifth impulses the escapement wheel will be free to move in a counter-clockwise direction, and when the marking or stop signal is transmitted, protrusion 30 will engage with the armature of electromagnet 16, thereby preventing further rotation of the escapement wheel until a spacing signal is again sent over line 31.

Rotation counter 29 is coupled to shaft 27 through gears 23 and 24 so that the counter registers one count for each complete revolution of shaft 27. Thus, one count as registered by counter 29 indicates that the escapement mechanism has completed the six steps required to permit the escapement wheel to make one revolution and that six code combinations and the corresponding six start and stop signals have been transmitted over line 31. In commercial communication systems it is common practice to designate six code combinations as representing one word including the space which separates that word and the succeeding word. Thus, the apparatus disclosed herein is adapted to indicate the cumulative number of groups of six characters transmitted over an electrical conductor, and this indication represents the cumulative number of words transmitted.

There remains for consideration the operation under the condition that a steady spacing signal is transmitted, whether it be an intentionally transmitted break signal or a line fault. Relay 12 responds in the same manner as previously described, releasing its armature to complete the energizing circuit of electromagnet 16 and interrupting the energizing circuit of relay 14. Electromagnet 16 releases escapement wheel 22 and the wheel begins to revolve. Relay 14 will release its armature in an interval not less than that of six successive spacing impulses, thereby interrupting the circuit of motor 15 which decelerates. Depending upon the number of revolutions the motor shaft undergoes in coming to a stop, the escapement wheel 22 will revolve through a proportional number of sixth revolutions. If the escapement wheel 22 completes a full revolution it will cause counting device 29 to register an additional word. It is within the contemplation of the invention that the characteristics of the motor 15 shall be such that the deceleration and coming to rest of the motor shall occur in not more than one revolution of escapement wheel 22.

Experience in the operation of telegraph circuits has shown that on the average, continuous spacing intervals which would cause the release of relay 14, whether intentional or fortuitous, occur not more than ten times during a day's operation. Ordinary teletypewriter transmission is at the rate of 3600 or more words per hour. Even if break signals or unintentional long spacing signals should be transmitted at the rate of ten per hour and assuming the registration of one word on indicator 29 for each such transmission, the deviation of the indication from the actual total of character codes transmitted would be well under one per cent. In the interest of simplicity and with the thought that such deviation would be tolerable from a practical and operating standpoint, the control exercised by relay 14 may be as shown in Fig. 1. In the event that a greater degree of accuracy is desired, it may be afforded by eliminating the deceleration time of motor 15 as a factor in the operation of

escapement wheel 22 following the release of relay 14. For example, there could be added to the device a clutch, either friction or positive, interposed between the shaft of motor 15 and gear 19, together with a stop magnet having its energizing circuit controlled by relay 14, with motor 15 arranged to run continuously. Such clutch and stop magnet might, for example, be of the type shown in Patent 2,055,567 granted September 29, 1936 to E. F. Watson, and the disclosure of the Watson patent is incorporated herein by reference as part of the present specification. With such an arrangement the release of relay 14 would result in the release of the stop magnet, which would cause gear 19 to be arrested in not more than one revolution after the release of stop magnet. Since the relay 14 must hold its armature for the interval of at least six successive spacing impulses, and may hold its armature for as much as a full code combination including the stop impulse time, the escapement wheel 22 might be expected to have exceeded one-sixth revolution at the time of the release of the armature of relay 14. Because of the speed reducing gear relation between gears 19 and 20, and because of the fact that gear 19 could be stopped in not more than one revolution by means of the stop magnet, the escapement wheel would be stopped before it has traveled one-third of a revolution from the point at which it was released and consequently the deviation of the indication from a true count would not exceed one word for each three line interruptions.

It will be apparent that when relay 14 releases in response to conditions hereinbefore described, and shaft 17 is brought to rest, whether by the stopping of motor 15 or the stopping of gear 19 by means of a clutch, escapement wheel 22 may stop in a position of partial completion of one of its one-sixth revolution steps, with one of the protrusions 30 of the escapement wheel having passed the blocking lug of the armature of electromagnet 16 and the next protrusion 30 not having reached the blocking lug, which is equivalent to the instantaneous condition shown in Fig. 2. Upon the reenergization of line 31 and line relay 12, relay 14 will be reoperated, shaft 17 will be restarted, and electromagnet 16 will be released. Teletypewriter systems are frequently operated at a speed of 60 words per minute or higher, from which it follows that the speed of rotation of escapement wheel 22 equals or exceeds one revolution per second. Accordingly, the escapement wheel 22 will be brought to rest by the armature of electromagnet 16 in an interval less than one-sixth of a second, and the arrestment of the escapement wheel 22, so that it will thereafter operate in the proper phase relation to the start and stop impulses of telegraph signals, may be accomplished merely by delaying message signal transmission for an interval of the order of one-sixth second, or slightly longer if the motor 15 is slow in coming up to speed.

It will be observed that the counting apparatus may be connected at any point along a line interconnecting teletypewriter stations and that any number of stations may transmit code characters over the line. It is apparent that the apparatus could easily be adapted to register representations of single characters of groups of any predetermined number of characters. The word counter is particularly adapted to making teletypewriter line traffic studies.

Although a specific embodiment of the inven-

tion has been shown and described, it will be understood that modifications may be made therein without departing from the scope and spirit thereof as defined by the appended claims.

What is claimed is:

1. A counting apparatus comprising an electrical conductor interconnecting a plurality of teletypewriter stations, a driving motor, a registering mechanism, interconnecting means including an escapement mechanism and a friction clutch between said driving motor and said registering mechanism, said interconnecting means being adapted to rotate at a speed which has a fixed submultiple relation to the speed of rotation of the receiving shafts of said teletypewriter stations, and a controlling device responsive to signaling impulses in said conductor and adapted to control the rotation of said escapement mechanism and interconnecting means in accordance with predetermined ones of said signaling impulses, thereby causing said registering mechanism to cumulatively register groups of transmitted code signal representations of characters in which each group comprises code signal representations equal in number to the reciprocal of said submultiple, said controlling device being adapted to deactivate said driving motor if said electrical conductor is deenergized for a predetermined length of time.

2. A counting apparatus comprising an electrical conductor interconnecting a plurality of teletypewriter stations over which code signals representing characters are transmitted, each code representation of a character being preceded by a first predetermined electrical condition and followed by a second predetermined electrical condition, a driving motor, a registering mechanism, interconnecting means including an escapement mechanism and a friction clutch between said driving motor and said registering mechanism, said interconnecting means being adapted to rotate at a speed which has a fixed submultiple relation to the speed of rotation of the receiving shafts of said teletypewriter stations, and a controlling device responsive to signaling impulses in said electrical conductor and adapted to cause said escapement mechanism and interconnecting means to rotate when said first predetermined electrical condition is transmitted over the electrical conductor and to continue rotating until said second predetermined electrical condition is transmitted over the electrical conductor, thereby causing said registering mechanism to cumulatively register groups of transmitted code signal representations of characters in which each group comprises code signal representations equal in number to the reciprocal of said submultiple.

3. A counting apparatus comprising an electrical conductor interconnecting a plurality of teletypewriter stations over which code signals representing characters are transmitted, each code representation of a character being preceded by a start signal comprising a time interval during which said electrical conductor is in a non-conducting condition and each code representation of a character being followed by a stop signal comprising a time interval during which said electrical conductor is in a conducting condition, a driving motor, a registering mechanism, interconnecting means including an escapement mechanism and a friction clutch between said driving motor and said registering mechanism, said interconnecting means being adapted to ro-

tate at a submultiple of the speed of rotation of the receiving shafts of said teletypewriter stations, and a controlling device adapted to cause said escapement mechanism and interconnecting means to rotate when said start signal is transmitted over the electrical conductor and to arrest said escapement mechanism and interconnecting means when said stop signal is transmitted over the electrical conductor, thereby causing said registering mechanism to cumulatively register groups of transmitted code signal representations of characters in which each group comprises code signal representations equal in number to the reciprocal of said submultiple.

4. In association with a start-stop permutation code telegraph system including a telegraph line, a counting device, driving means therefor, an escapement mechanism operatively interconnecting said driving means and said counting device and having an operating time per escape cycle substantially equal to the time required for a start-stop permutation code signal combination, means responsive to spacing impulse transmission over said line for initiating an escape cycle of said escapement mechanism whereby to effect an incremental operation of said counting device, and means responsive to prolongation of said spacing impulse appreciably beyond said escape cycle operating time for stopping said escapement mechanism.

5. In a counting apparatus, a normally energized communication conductor, means for transmitting code signals involving interruptions in the energizing current over said conductor, a registering means, a driving means therefor, interconnecting means between said driving means and said registering means, a controlling device responsive to interruptive conditions of said code signals for activating said interconnecting means to cause said registering means to register a summation of code signals transmitted over said conductor, and means responsive to an interruptive condition exceeding a predetermined duration for deactivating said driving means.

6. In a communication system in which fixed and equal numbers of code signal combinations represent words for counting purposes, a communication conductor, means for transmitting code signal combinations over said conductor, a registering device, a driving means therefor, interconnecting means between said driving means and said registering means adapted to advance said registering means one unit for each revolution of said interconnecting means, and a controlling device responsive to code signal combinations and adapted to cause a fraction of a revolution of said interconnecting means equal to the reciprocal of said fixed and equal number whereby each unit registered by said registering means represents a word.

WILMARTH Y. LANG.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,744,259	Carlson	Jan. 21, 1930
2,023,574	Cohn	Dec. 10, 1935
2,086,913	Kelly, Jr.	July 13, 1937
2,191,798	McCann	Feb. 27, 1940
2,392,256	Nichol	Jan. 1, 1946
2,421,681	Chaskin	June 3, 1947