

July 28, 1953

T. REUMERMAN ET AL.

**2,646,923**

DEVICE FOR DETERMINING CHECK SYMBOLS

Filed Aug. 27, 1948

2 Sheets-Sheet 1

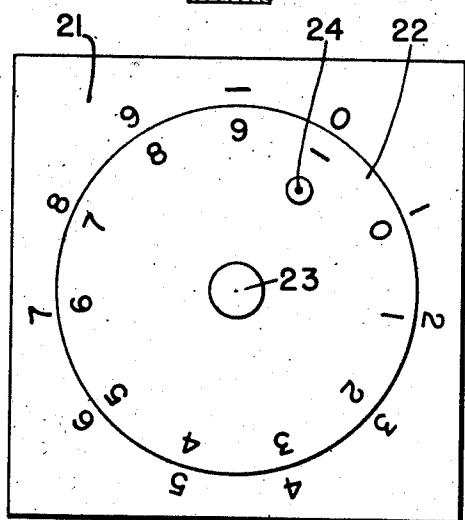
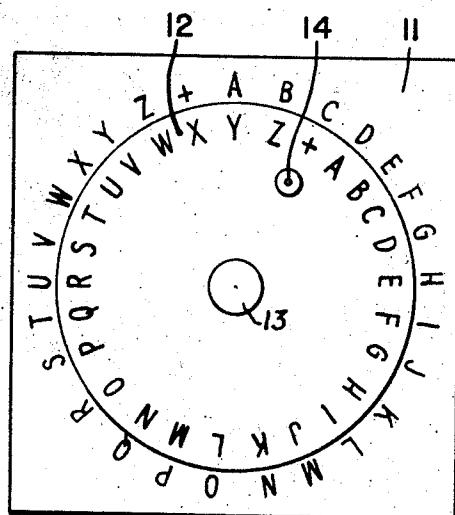
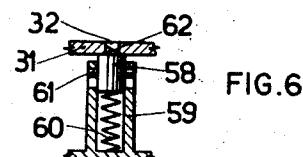
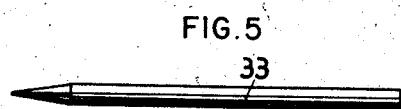
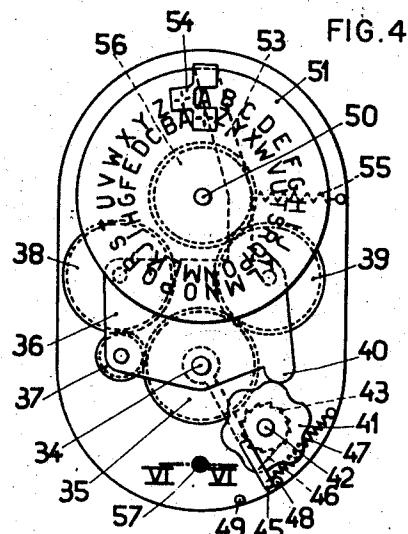
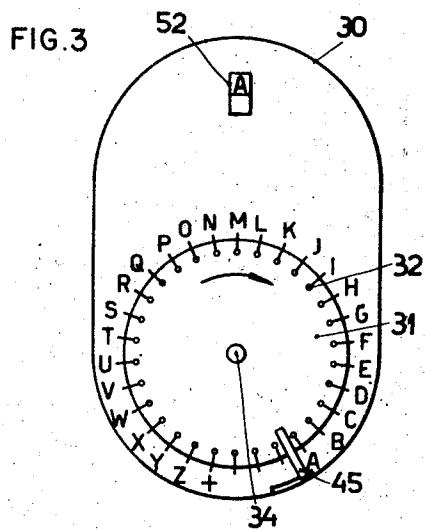


FIG. 1

FIG. 2

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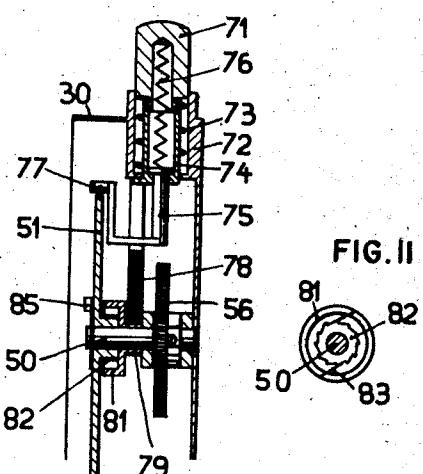
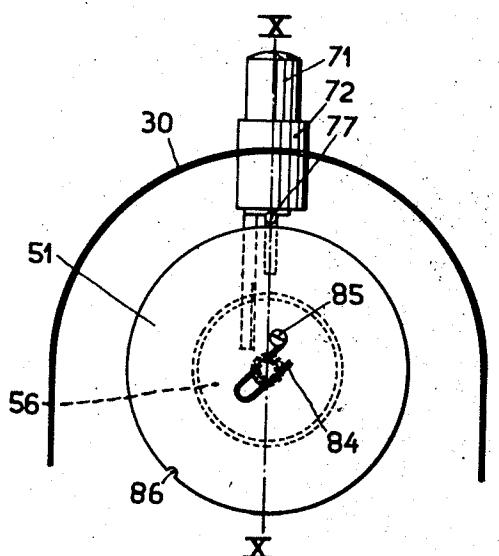
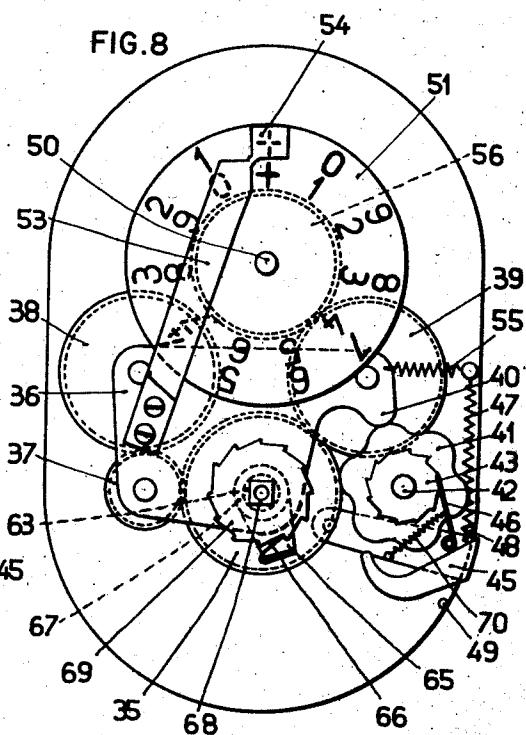
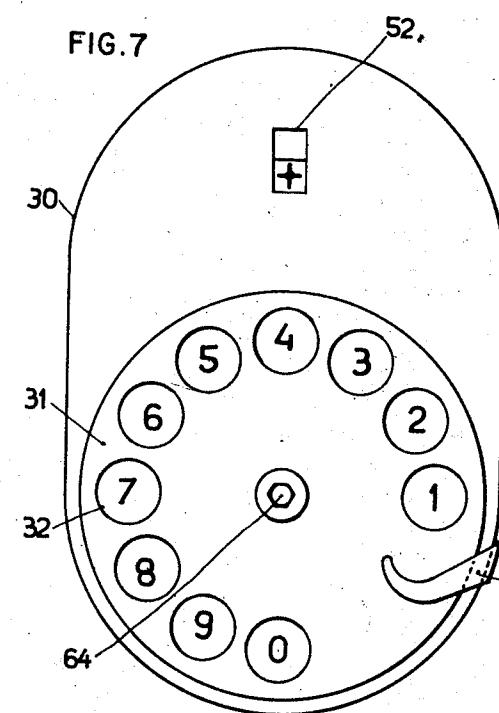


FIG. 10

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## UNITED STATES PATENT OFFICE

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## DEVICE FOR DETERMINING CHECK SYMBOLS

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15 Claims. (Cl. 235—61)

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The invention relates to a device for determining a check symbol for a symbol group comprising an arbitrary number of symbols selected from a given series, such as the alphabet.

In the telegraphic and radio telegraphic transmission of intelligence the transmitted messages are frequently made incomprehensible by mutilations. Also, the meaning, of a message may be modified by mutilations in such manner that serious misunderstandings occur on the receiving side. Particularly, in the transmission by means of Teletype telegrams, such as are used in the so-called teleprinter traffic, much trouble is caused by mutilations.

In the transmission of intelligence for commercial purposes, in particular by means of cable and radio messages, a frequent use is made of codes. These may be distinguished in letter and figure codes. With letter codes, the intelligence is transmitted by means of code words, made up in any desired manner out of the letters of the alphabet. In the use of figure codes, a plurality of figures are combined to a code number, which may, if desired, be translated into a code word by means of special tables. The use of codes provides for a considerable saving of telegram expenses. On the other hand mutilations may easily lead to mistakes.

It is an object of the invention to provide means whereby mutilations in any kind of intelligence may be detected and corrected in a simple manner and with great certainty.

Other objects of the invention are:

To append a check symbol to each symbol group, by means whereof any one symbol mutilations, and mutilations caused by a transposition of two successive symbols may readily be detected and corrected;

To provide various kinds of expedients, by means of which the check symbol of a given symbol group may easily be determined;

To provide expedients for determining the substitution symbols required for correction of one symbol mutilations;

To provide means for checking a telephone number selected by a subscriber in an automatic telephone system, in order to prevent false connections;

To provide a device to be incorporated in the telephone apparatus of a subscriber for checking each selected telephone number.

Further objects of the invention, and the exact nature thereof, will be apparent from the following detailed description of some embodiments thereof, given with reference to the accompanying drawing, wherein

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Fig. 1 is a top view of a device for determining the substitution letters required for the correction of one letter mutilations;

Fig. 2 is a top view of a similar device for determining the substitution figures required for the correction of one figure mutilations in numbers;

Fig. 5 is a top view of a mechanical device for determining the check symbol appertaining to a given symbol group;

Fig. 4 shows the same device after removal of the dial and the top of the casing;

Fig. 5 shows a pin for operating the device shown in Figs. 3 and 4;

Fig. 6 is an enlarged cross section, taken along the line VIII—VIII of Fig. 4, of a detail of the device shown in Figs. 3 and 4;

Fig. 7 is a top view of a device to be attached to a telephone apparatus for checking a selected telephone number;

Fig. 8 shows the same device after removal of the dial and the top of the casing;

Fig. 9 is a front view of a modification of the device shown in Figs. 7 and 8, incorporating a push button for returning the check figure wheel to its initial position;

Fig. 10 is a cross section of the same device, taken along the line XIII—XIII of Fig. 9;

Fig. 11 shows a detail of the device illustrated in Figs. 9 and 10.

The invention may be applied to messages transmitted in ordinary language and to code messages making use of any desired letter or figure code. Consequently, the words and numbers used for the transmission of intelligence are hereinafter indicated by the term "symbol groups." Such a symbol group may consist, inter alia, of:

1. A word from any ordinary language, or a sequence of two or more of such words,

2. A number forming part of a message, or a sequence of two or more of such numbers,

3. A code word, comprising any desired number of letters, or a sequence of two or more of such code words,

4. A code number, consisting of an arbitrary combination of figures, or a sequence of two or more such code numbers.

Code words and code numbers will be indicated hereinafter by the expression "code groups," whereas the letters and figures, of which the message consists, will be indicated as "symbols." The invention may also be applied to messages comprising two or more of the above-mentioned kinds of symbol groups.

Various methods are known for preventing

mistakes in the transmission of code messages. The so-called five letter codes, wherein each code word consists of five letters are composed in such manner that there is a difference, of at least two letters between any pair of code words. Upon mutilation of one letter the error is immediately found on the receiving side and the correct code word may be determined with the aid of rather complicated correction tables.

With the known three letter codes, a check number is ascribed to each code word. Three successive code words are combined to a nine letter group, and the check numbers of these three words are added together, whereupon a tenth letter is appended, indicating the value of the sum of the check numbers. After that, the ten letter group is split up into two five letter groups, which are separately transmitted. On the receiving side, a mutilation may be detected by computing the sum of the check numbers of the received words, and comparing it with the received check letter. A correction is possible with the aid of very complicated correction tables. However, this correction takes up a lot of time.

In the transmission of messages by means of figure codes, it is usual to append to the code number a figure indicating the last digit of the sum of the figures of the code number. Although this method provides a check for a mutilation of one figure, it does not offer any guarantee against another frequently occurring error, to wit the transposition of two successive figures.

According to a main feature of the present invention, a characteristic number is ascribed to each symbol of the series out of which the symbol groups are composed and there is added to each symbol group a check symbol corresponding in a predetermined manner with a check number obtained by subtracting the sum of the characteristic number of the symbols appearing in the even positions of the symbol group from the sum of the characteristic numbers of the symbols appearing in the odd positions, the even and odd positions of the symbol group being established by counting from right to left.

The invention will be more readily understood by reference to the following detailed description of some embodiments thereof, and of the expedients adapted to be used in connection with the invention, which are shown in the accompanying drawing.

In order to explain the principle of the invention, a simple example will be considered, wherein a letter code is used, and wherein all code words consist of the same number, for instance of five letters, which may be selected from the whole alphabet.

First of all, a characteristic number will have to be ascribed to each of the letters of the alphabet. Although the choice of these numbers is quite arbitrary, it is preferred to number the letters in alphabetical order, for instance: A=0, B=1, C=2, D=3, etc.

It is assumed that the code word DEMOT has to be transmitted. Counting from right to left, we find that the letters T, M and D appear in the odd positions, and the letters O and E in the even positions. The characteristic numbers of the letters T, M and D are 19, 12 and 3, respectively, whereas the characteristic numbers of the letters O and E are found to be 14 and 4.

According to the invention, a check number is ascribed to the word DEMOT, and this check number is obtained by subtracting the sum of the characteristic numbers of the even letters O and

E from the sum of the characteristic numbers of the odd letters T, M and D. Thus  $14+4=18$  must be subtracted from  $19+12+3=34$ , and the check number is found to be  $34-18=16$ . By transmitting the check number 16 together with the code word in any desired manner, means are provided for checking on the receiving side whether or not the code word has been mutilated. Of course, the check number 16 could be transmitted itself for this purpose, but it is more suitable to ascribe a letter to each check number, and to transmit this letter together with the code word. This may again be realized in the simplest manner by ascribing the letters of the alphabet in their usual order to the check numbers, for instance: 0—A, 1—B, 2—C etc.

Thus, the check number 16 corresponds to the letter Q, so that the check letter Q will have to be transmitted together with the code word DEMOT. This may be done by incorporating the check letter in the code word in a predetermined position, for instance at the end thereof (DEMOTQ).

However, this latter procedure gives rise to some difficulties in the case that a five letter code is used because the telegraph administrations generally apply a higher scale of charges to code words consisting of more than five letters. To remove this drawback, the check letters of a sequence of at most five words of a message may be noted down and combined into a check group which is appended as an additional word to the said sequence.

Upon checking on the receiving side practically all mutilations are established. The most frequently occurring error is the so-called one letter mutilation, wherein one letter of a word is wrongly transmitted. This error will always be found, since the check number and the corresponding check letter will always be altered by a change of one letter. For instance, if the word DEPOT is received together with the check letter Q, instead of the intended word DEMOT, this error is immediately found, because the check number of the word DEPOT is equal to  $(19+15+3)-(14+4)=37-18=19$ , so that the corresponding check letter is T, and not Q.

The error may be corrected in a very simple manner by making use of the following considerations. The received check letter Q corresponds with a check number which is 3 less than the check number determined on the transmitting side. Thus the error may be caused by a one letter mutilation, whereby one of the odd letters has been replaced by a letter of which the characteristic number is 3 more, or whereby one of the even letters has been replaced by a letter of which the characteristic number is 3 less.

In order to correct the error, the letters of the received word are alternately substituted by another letter, of which the characteristic number is 3 less for the odd letters and 3 more for the even letters. Thus, the letters T, P and D are alternately replaced by Q, M and A, and the letters O and E by R and H, so that the following new words are found: DEPOQ, DEMOT, AEPOT, DEPRT and DEHPOT. All of these words have the check letter Q. Of course, the error may also consist of a faulty transmission of the check letter, so that the received word DEPOT must be added to the above group. From the group of six words obtained in this manner a choice is made which is acceptable in connection with the context. If none of the six words is acceptable, another error must have been made,

and a further correction may be applied which will be described hereinafter. In the present case, of course the word DEMOT is found.

The above-described correction of one letter mutilations is greatly facilitated by the circumstance that the check numbers associated with each letter of the alphabet are connected in a simple manner with the characteristic numbers of these letters. In the example, both the check numbers and the characteristic numbers correspond with the letters in alphabetical order. Thus, if the check letter determined on the receiving side is shifted in the alphabet with respect to the received check letter over three positions, the correction may be carried out by alternately shifting the letters of the received word over three positions, in the same direction for the even letters, and in opposite direction for the odd letters. This advantage is still obtained if a fixed amount must be added to, or subtracted from the check numbers to find the characteristic numbers of the associated check letters.

Another frequently occurring error is a transposition of two successive letters. This error is also established upon checking, since the check number is altered by the transposition. Suppose that the word EDMOT is received together with the check letter Q, instead of the intended word DEMOT. The check number of the word EDMOT amounts to

$$(19+12+4)-(14+3)=35-17=18$$

so that the check letter ought to be S instead of Q.

In order to correct this error, each two successive letters of the received word are alternately exchanged, and the check letters of the new words are determined. Of course, if the check letter was incorporated in the word upon transmission, it must also be included in these exchanges, since it may have been involved in a transposition. After that, the word having the correct check letter is selected.

In the present case, the following new code groups are formed: DEMOTQ, EMDOTQ, EDOMTQ, EDMTOQ and EDMOQT. The check numbers of the words DEMOT, EMDOT, EDOMT, EDMTO and EDMOQ are 16, 0, 22, 13 and 15, respectively, so that the corresponding check letters are Q, A, W, N and P. Thus, the word DEMOT is found to be the only one which has the right check letter, so that this word must be the correct one.

It is to be noted that transpositions in which the check letter is involved are only found with certainty if the order wherein the letters of the alphabet are ascribed to the check numbers is the same as the order wherein the letters are associated with their characteristic numbers. Hence, if the check letters are incorporated in the words upon transmission, it is desirable to associate the letters with the check numbers and with the characteristic numbers in the same order. If, on the other hand, the check letters are transmitted in separate check groups, the check numbers and the characteristic numbers related to each letter of the alphabet may have a different order. However, since the correction of one letter mutilations would be made more difficult thereby, it is preferred to use the same order for the check numbers and the characteristic numbers in all cases.

If neither of the above-described corrections of one letter mutilations and transposition errors leads to an acceptable result, it is clear that some

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25  
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other kind of mutilation must have occurred, for instance an arbitrary mutilation of two or more letters. Although such a mutilation cannot easily be corrected, it is discovered in most cases upon checking, and may then be removed by an inquiry. In practice, it is found that 99.9% of the occurring errors are discovered by means of the present invention, whereas 97.2% may be corrected on the receiving side.

It was taken for granted hereinbefore that all letters of the alphabet are used for indicating the check numbers. In principle, it would be possible to use a smaller number, for instance only 15 letters, as check letters. Thus, after ascribing the letter O to the check number 14, the letter A would again be ascribed to the check number 15, the letter B to 16, etc. However, this would lead to the disadvantage that two words having a difference of one letter could have the same check letter. For instance, in this system, the word DEMOT would have the check letter B, whereas DEMOE would also have the check letter B. To avoid this objection, it is preferred to make the number of symbols of the series from which the check symbols are taken at least equal to the number of symbols of the series out of which the symbol groups are composed. Thus, if all letters of the alphabet are used for composing the symbol groups, all letters must also be used as check symbols.

However, if the choice of the check symbols is restricted to the letters of the alphabet, there is still some slight difficulty, to wit that a transposition of two successive letters of which the characteristic numbers differ by 13, will not be discovered upon checking. For instance, if the word REMOT is to be transmitted, wherein the first two letters have the characteristic numbers 17 and 4, a transposition error whereby the word ERMOT is received, will not be established. The check number of the word REMOT is  $(19+12+17)-(14+4)=48-18=30$ . Now, if after ascribing all letters of the alphabet to the check numbers 0-25, the letter A is again ascribed to the check number 26, the letter B to 27, etc. the letter E is found to correspond with the check number 30. The check number of the word ERMOT is  $(19+12+4)-(14+17)=35-31=4$ , so that this word would also have the check letter E. Thus both words are found to have the same check letter.

This appears to be due to the fact that the number of the letters of the alphabet is even. If an odd number of check symbols were used, this difficulty could not occur. Therefore, when the invention is applied to messages in ordinary language or to code messages making use of all letters of the alphabet, it is preferred to add a 27th symbol to the service from which the check symbols are taken. Since the telegraph administrations do not allow the use of other symbols than ordinary letters in code telegrams, an open space, i. e. an omission of the check letter, is preferably used as a 27th check symbol. Thus, while a check letter is added to all other words, it is omitted with a word having the check number 26, such as the word NEMOT. The letter A is now again ascribed to the check number 27, the letter B to 28, etc. so that the check letter D corresponds with the check number 30, and the words REMOT and ERMOT have different check letters. A transposition of two successive letters will now be found upon checking under all circumstances.

Thus, a preferred embodiment of the invention is found to consist of a system wherein the char-

acteristic numbers 0-25 are ascribed to the letters in their alphabetical order, and wherein the letters are ascribed in their alphabetical order to the check numbers 0-25, the check symbol of a word having the check number 26 consisting of an open space. If in this system, a check number over 26 is found, 27 must be subtracted to find the characteristic number of the check letter. For instance, the check number 30 corresponds to the characteristic number  $30-27=3$ , i. e. to the check letter D. If a check number over 53 is found, 54 must be subtracted. For instance, the word ZAZAZ has the check number  $(25+25+25)-(0+0)=75-0=75$ , so that the characteristic number of the check letter is  $75-54=21$ , and the check letter is found to be the letter V. If a negative check number is found, 27 or a multiple of 27 must be added to find the characteristic number of the check letter. For instance, the word AZAZA has the check number  $(0+0+0)-(25+25)=0-50=-50$ , so that the characteristic number of the check letter is found to be  $-50+54=4$ , corresponding with the letter E.

In the above-described correction of one letter mutilations, a fixed amount (equal to 3 in the example) had to be added to, or subtracted from the characteristic numbers of the letters of the received word in order to determine the characteristic numbers of the substitution letters. If in such a computation a negative number, or a number over 26 is found, the correct characteristic number may again be found by adding or subtracting 27. Of course, if the characteristic number of the substitution letter is found to be 26, this means in general that the substitution is impracticable.

By way of example, there will now be indicated how an arbitrary message of five words is transmitted with the aid of the preferred checking system mentioned above. For simplicity, code words will be used for which the check letters have already been determined. Suppose that the following message is to be transmitted: DEMOT DEPOT NEMOT REMOT ERMOT. The appertaining check letters are, respectively: Q, T, open space, D and E.

Now, if the check letters are to be incorporated in the words, the following sequence of code groups is transmitted: DEMOTQ DEPOTT NEMOT REMOTD ERMOTE. From the fact that the group NEMOT contains only five letters, it follows that the open space has been used to indicate the check number.

If, on the other hand, the check letters are to be combined into a separate check group, the message is transmitted as follows: DEMOT DEPOT NEMOT REMOT ERMOT QTDE. From the fact that the check group contains only four letters it follows that the open space constitutes the check symbol of one of the transmitted code words, but it is not yet known to which word the open space belongs. As a rule, this will become evident upon determining the check symbols of the received code words. However, if a one letter mutilation occurs in two successive words and one of these words has the open space for a check symbol, there is still some uncertainty. In this case, the correction must be based upon the assumption that the open space belongs to one of the two words, and if this does not lead to an acceptable result, the open space must be ascribed to the other word. Of course, such a coincidence will be very exceptional.

In drafting a new code, the use of the open space as a check symbol may be avoided by leaving out some letters in the composition of the code words. For instance, 25 letters of the alphabet might be used as check symbols, and 25 of these letters for the composition of the code words.

As stated above, the application of the invention to an arbitrary five letter code involves some difficulties because the telegraph administrations apply a higher scale of charges to code words containing more than five letters, so that the check letters have to be combined into separate check groups.

However, this complication only arises if it is necessary to transmit all letters of each code word to prevent misunderstandings. With the existing five letter codes, wherein each pair of words have a difference of at least two letters, this is not the case. In fact, in such a code the last letter of each word may be omitted without causing any misunderstanding, since the remaining four letter groups are still all different. By determining the check letters of these four letter groups by means of the present invention, and substituting these check letters for the omitted letters, all advantages of the invention may be obtained without additional telegram expenses. As two four letter groups having a difference of one letter will always have different check letters, the new five letter code obtained by the above procedure will present a difference of at least two letters between any two code words.

The invention may be applied to the existing three letter codes by appending a check letter to a sequence of three code words. In drafting a new code to be used in combination with the present invention, it is preferable to make use of four letter words having a difference of at least one letter between any two of them. By appending a check letter to each of these words, a five letter code is obtained, wherein any two words have a difference of at least two letters.

Of course, the invention may also be applied to codes consisting of words of different length, and to messages in ordinary language. In the latter case, a check letter may be appended to each word, or to a sequence of two or more words.

In the above explanation of the invention, the check number of each symbol group was determined by a computation. Although this computation is a very simple one, it may take up rather a lot of time under certain circumstances. This disadvantage may be removed by making use of some simple expedients, by means of which the check and substitution letters may be determined without any computation.

The device shown in Fig. 1 comprises a bottom disc 11 and an upper disc 12, consisting of any suitable material, such as metal, wood, card board, or the like. The letters of the alphabet and an open space marked by a dash are arranged along a circle on the bottom disc 11. The upper disc 12 has a circular shape and also carries the letters of the alphabet and an open space, placed in the same order and spaced at the same distances with respect to each other as on the bottom disc. The upper disc is rotatable with respect to the bottom disc about an axis of rotation 13 so that a selected letter of the upper disc may be placed opposite to any desired letter of the bottom disc. An operating member 14, which may consist of a piece of cork

stuck to the upper disc, is provided for facilitating the rotation of the upper disc.

The use of the device is as follows. The check letter determined on the receiving side is looked up on the bottom disc, and the check letter received with the transmitted word is placed opposite thereto by rotation of the upper disc. Now, the odd letters of the received word are looked up on the bottom disc, and the substitution letters are found opposite to these letters on the upper disc. The even letters of the received word are looked up on the upper disc and the substitution letters are found opposite thereto on the bottom disc.

For instance, suppose that the word DEPOT has been received together with the check letter Q, instead of the intended word DEMOT. The check letter of the word DEPOT is T, and this letter is looked up on the bottom disc 11. The received check letter Q is looked up on the upper disc 12 and placed opposite to the letter T on the bottom disc by rotation of the upper disc. Opposite to the odd letters T, P and D of the received word on the bottom disc are the letters Q, M and A of the upper disc. Opposite to the even letters O and E on the upper disc are the letters R and H on the bottom disc. Thus, the letters D, E, P, O, T of the received word are to be alternately replaced by the substitution letters A, H, M, R and Q, so that the substitution words AEPOT, DHPOT, DEMOT, DEPRT and DEPOQ are found, from which an acceptable word is selected.

The device shown in Fig. 2 is similar to that of Fig. 1 except that the discs 21 and 22 contain the figures from 0 to 9, followed by an open space. This device is used to correct one figure mutilations in the transmission of numbers. The operation is the same as that of the device shown in Fig. 1.

For determining the check symbol of a given symbol group, the invention further provides a device comprising a selector, such as a key board or a telephone type dial, by means of which the symbols of the group may be successively selected, and an indicator with a scale containing all check symbols, the said indicator being displaced in one direction upon selection of the odd symbols of the group, and in opposite direction upon selection of the even symbols, each displacement being proportional to the characteristic number of the selected symbol, so that the indicator shows the check symbol after selection of the last symbol of the group.

As stated hereinbefore, the odd and even positions of the symbol groups are to be determined by counting from right to left. Thus, for groups consisting of an odd number of symbols the indicator would have to be displaced in a positive sense upon selection of the first symbol, and in a negative sense upon selection of the second symbol. On the other hand, for groups consisting of an even number of symbols, the indicator would have to be displaced in a negative sense upon selection of the first symbol, and in a positive sense upon selection of the second symbol. To avoid this difficulty, it is preferred to provide the indicator with two scales containing the check symbols in opposite order. The indicator may now be displaced in an arbitrary sense upon selection of the first symbol of the group, and this sense will be positive for one of the scales and negative for the other one. The two scales are alternatively operative, in such manner that the first-mentioned scale is operative

after selection of the first, third, fifth symbols, and the other scale after selection of the second, fourth, sixth symbols, etc. Thus, after selection of a complete group consisting of an odd number of symbols, the first-mentioned scale will be operative, for which the sense of the first displacement was positive, whereas the scale, for which the sense of the first displacement was negative, will be operative after selection of complete group consisting of an even number of symbols.

A preferred embodiment incorporating this feature is shown in Figs. 3-5 of the drawing.

The device shown in Figs. 3 and 4 comprises a casing 30, on which the letters of the alphabet are arranged along a circle in their usual order, followed by a +. A dial 31 is placed above the casing and provided with a plurality of holes 32, into which a pin 33 (Fig. 5) may be inserted for selecting a desired letter. The holes 32 are spaced at the same distances as the letters arranged on the casing, so that each letter is opposite one of the holes. In order to obtain a sufficient space for operation of the dial, the number of holes has been chosen slightly greater than that of the symbols arranged on the casing. For instance, as shown in the drawing, thirty holes may be provided.

The dial 31 is fixedly mounted on a shaft 34, supported in the top and bottom of the casing, and carrying a toothed wheel 35. A rocking member 36 is rotatable around the shaft 34, and supports a pair of toothed wheels 37, 38 in engagement with each other, and a toothed wheel 39. Upon a rocking movement of the member 36, the toothed wheels 37 and 39 roll over the toothed wheel 35.

The rocking member 36 is provided with a cam 40, co-operating with a cam disc 41 mounted on a rotatable shaft 42, which also carries a ratchet wheel 43. An arm 45 is rotatable around the shaft 34, and has its end bent around the dial 31 into the path of the holes 32. The arm 45 is provided with a pawl 46 co-operating with the ratchet wheel 43, and is drawn towards said ratchet wheel by a spring 47. The displacement of the arm 45 is limited by stop members 48 and 49.

A rotatable shaft 50 supported by the casing 30 carries a check letter wheel 51, on which the check symbols A-Z, followed by a +, are arranged in opposite order along two closed concentric circles. A window 52 is cut out of the top of the casing, and the rocking member 36 is provided with an arm 53 carrying a covering plate 54 alternately covering the upper and lower parts of the window 52, so that only one symbol is visible through the window at any time. A spring 55 connected with the arm 53 keeps the cam 40 pressed against the cam disc 41. The shaft 50 further carries a toothed wheel 56, engaging either of the toothed wheels 38 and 39, according to the position of the rocking member 36.

The dial 31 can rotate in clockwise direction only (as indicated by the arrow), a backward movement being prevented by a resilient stop member 57, shown in detail in Fig. 6. This stop member comprises a cylindrical body 58, slidably arranged in a cylindrical guide bush 59, and pressed upward by a spring 60. The displacement of the body 58 is limited by a side-wardly projecting pin 61, moving in slots provided in the guide bush 59. The body 58 carries a head 62 having the shape of an obliquely

truncated cylinder and adapted to engage the openings 32. As appears from Fig. 4, the dial 31 can be freely moved to the left, the body 58 being then pressed down into the bush 59. However, a movement to the right is impossible.

The operation of the device is as follows. In the initial position, the letter A appears before the window 52. Now, if the check letter of the word DEMOT is to be determined, the pin 33 is inserted into the hole 32 which is opposite to the letter D on the casing, and the dial is turned by means of the pin as far as possible. If the rocking member 36 has the position shown in the drawing, the check letter wheel 51 is driven by means of the toothed wheels 35, 39 in a clockwise direction, the outermost row of check letters being visible in the window 52. At the end of the movement of the dial, the pin 33 engages the arm 45, which is taken along until it abuts against the stop member 49.

Now, the pin 33 is taken out of the hole, and the arm 45 is moved back by the spring 47, taking along the ratchet wheel 43 by means of the pawl 46. Thus, the cam disc 41 is shifted over one position, and the rocking member 36 is rotated so as to bring the toothed wheel 56 out of engagement with the toothed wheel 39, and into engagement with the toothed wheel 38. At the same time, the arm 53 displaces the covering plate 54, and the letter D appears in the lower half of the window 52. During the backward movement of the arm 45, the dial is kept in its place by the resilient stop member 57.

The pin 33 is now inserted in the hole 32 which is opposite to the letter E on the casing, and the dial is again rotated as far as possible. The check letter wheel 51 is now driven in a counter-clockwise direction by means of the toothed wheels 35, 37 and 38. At the end of the movement of the dial, the pin 33 again engages the arm 45, which is taken along until it abuts against the stop member 49. Upon removal of the pin 33 from the hole, the arm 45 is drawn back against the stop member 48, and the cam disc 42 is again shifted over one position, so that the rocking member 36 is brought back into its initial position. The letter B now appears in the upper half of the window 52.

The letters M, O and T are now dialed in the same manner, and it will be understood that the check letter wheel is rotated in alternate directions, each angle of rotation corresponding with the characteristic number of the selected letter. After selection of the last letter T the desired check letter Q appears in the lower half of the window 52.

The check letter wheel 51 may now be brought back into the starting position by inserting the pin 33 in the hole 32 which is opposite to the letter Q on the casing, and rotating the dial as far as possible, whereupon the letter A again appears in the window 52. It is to be noted that the device has the general property that the check letter wheel is always brought back to the starting position by dialing the symbol appearing in the window. For this reason, the symbol + has been indicated on the casing, so that the check letter wheel may also be brought back to its initial position after finding the symbol + (i. e. the open space) as a check symbol.

In the above-mentioned case, the rocking member has been shifted six times, so that it again occupies the position shown in the drawing. It is to be noted, however, that the actual starting position of the rocking member is of

no consequence whatever. For instance, if the check letter of a four letter word has been determined, and the check letter wheel has subsequently been brought back to its starting position by dialing the check letter, the rocking member has been shifted five times and therefore occupies a position which is different from the initial one. Upon dialing the first letter of the next word, the check letter wheel will now move counterclockwise, but this does not make any difference in the results of the operation.

As appears from the drawing the two rows of check symbols indicated on the check letter wheel have been shifted with respect to each other 15 over one position, so that the letter A of one row is opposite to the symbol + in the other row. This has been done because the letter "A" has the characteristic number 0, whereas the dial makes one step upon selection of the letter 20 A. Thus, it will be seen that the number of steps of the dial is always one greater than the characteristic number of the selected letter. This does not make any difference in the established 25 check letter for words consisting of an odd number of letters, but for an even number of letters the number of steps over which the check letter wheel is displaced will be one greater than the characteristic number of the appertaining check letter. This difference is compensated for 30 by shifting the scale used for words with an odd number of letters over one position.

As stated above, the toothed wheel 37 and 39 roll over the toothed wheel 35 during each movement of the rocking member 36. Thus, the 35 wheels 38 and 39 will rotate during the movement of the rocking member and under certain circumstances this rotation may cause a slight reciprocating movement of the check letter wheel 51. However, the final position of the check 40 letter wheel is not altered thereby, so that this phenomenon is of no consequence.

It will be understood that the gear ration of the toothed wheels 35 and 56 must be 10:9, in order that one step of the dial 31 may correspond with one step of the check letter wheel.

In the art of automatic telephony, the method according to the invention may be used for checking the telephone numbers dialed by a subscriber in order to prevent false connections. In 50 the language of the present specification, a telephone number may be considered as a symbol group, which is transmitted to the exchange by means of the dial. According to the invention, a check symbol may be determined for each 55 telephone number, and this check symbol may be indicated in the telephone director, or on a list of telephone numbers at the subscriber's. Means are provided for determining the check symbol of the selected number during the transmission thereof, so that this check symbol may be compared with the check symbol of the desired number, and the establishing of the connection may be prevented if the check symbols do not agree.

65 In determining the check symbols of telephone numbers, it is to be noted that the digit 0 is used in automatic telephony to indicate the number 10. Upon selection of the digit 0, ten impulses are transmitted by the dial. In the language of 70 the present specification, this means that the characteristic number 10 has been ascribed to the symbol 0. Thus, for instance, the check number of the group 29047 is found to be

$$(7+10+2)-(4+9)=19-13=6$$

As it is desirable that the check numbers and the characteristic numbers are associated with the digits in the same order, the check symbol 0 will have to be ascribed to telephone numbers having the check number 10. For instance, the telephone number 25047 has the check number

$$(7+10+2)-(4+5)=19-9=10$$

and will have the check symbol 0. Consequently, the open space (omission of the check symbol) will have to be used for telephone numbers having the check number zero. For instance, the telephone number 28347 will have the check number  $(7+3+2)-(4+8)=12-12=0$ , so that the open space will serve as a check symbol for this number.

In order to prevent false connections with the aid of the check symbols indicated in the directory, the check symbol of the number which is actually selected by the subscriber must be determined, so that it may be compared with the check symbol of the desired number. For this purpose, the subscriber's telephone apparatus may be provided with a device of the kind shown in Figs. 3-6, which is operated by the ordinary dial of the apparatus, and which indicates the check symbol of the actual number in a window or the like.

A preferred embodiment of such a device is shown in Figs. 7 and 8. Several parts of this device correspond with parts of the device shown in Figs. 3-6, and are indicated by the same reference numerals.

The device of Figs. 7 and 8 may be attached to any existing telephone apparatus by taking off the dial of the apparatus and attaching a hollow extension shaft 63, extending through the casing 30 of the device, to the dial shaft of the apparatus. After that, the dial 31 is placed on top of the extension shaft 63, and is fixed thereto and to the dial shaft of the apparatus by means of a screw 64 extending through the hollow shaft 63. The casing 30 is provided with Figures 1-0 arranged along a circle in the usual manner, so that the dial may be used for selecting a telephone number in the normal way.

A toothed wheel 35 and an arm 65, carrying a pawl 66, are fixedly attached to a bush 67, which is rotatable around the extension shaft 63. The shaft 63 is further provided with a square part 68, and a ratchet wheel 69 having a square hole fits around the square part 68 so as to be taken along by each movement of the shaft 63.

The displacement of the dial is limited by a hook-shaped arm 45 which is engaged by the finger of the operator at the end of each forward movement of the dial, and is taken along until it abuts against a stop member 49. After removal of the finger from the hole, the arm 45 is drawn back against the stop member 48 by a spring 47, and takes along the ratchet wheel 43 by means of the pawl 46, thereby shifting the cam disc 41 over one position as described in connection with the device of Figs. 3-6. A spring 70 serves to keep the pawl 46 pressed against the ratchet wheel 43.

Thus it will be seen that the rocking member 36 is shifted at the end of each forward movement of the dial, thereby reversing the direction of movement of the check figure wheel 51 and changing the position of the covering plate 54 in the same way as has been described with reference to Figs. 3-6.

The check figure wheel 51 bears two rows of check symbols in opposite order, each consisting

of the symbol + followed by the digits 1-0. As the dial is displaced over one step upon selection of the digit 1, a shifting of the rows of check symbols with respect to each other, as practised in the embodiment of Figs. 3-6, is not necessary in the present case. In the initial position of the wheel 51, the symbol + appears in the window 52.

Upon dialing a telephone number, the wheel 35 is taken along during each forward movement of the dial by means of the ratchet wheel 69 and the pawl 66. During each backward movement of the dial, the wheel 35 remains stationary. The wheel 35 drives the check figure wheel 51 in a clockwise or counterclockwise direction, according to the position of the rocking member 36.

Thus, it will be clear that the check symbol of the selected number will be determined, in the same way as described with reference to Figs. 3-6, so that the desired check symbol appears in the window 52 after selection of the last figure.

It is to be noted that the displacement of the check figure wheel 51 takes place during the forward movement of the dial, whereas impulses are transmitted to the exchange during its return movement. Thus, the check symbol of the selected number will appear in the window at the end of the last forward movement of the dial, i. e. before the last figure has been transmitted to the exchange, so that there is still time to cancel the call by laying the receiver on the hook if a wrong check symbol appears. By instructing the public to keep the finger in the hole of the dial until the number has been duly checked, false connections will be prevented with certainty in all cases wherein the check symbol has been altered by a mutilation of the number, that is for about 99.7% of the wrong numbers.

After checking the number, the check figure wheel 51 may be brought back into its initial position by dialing the figure appearing in the window 52, as described with reference to Figs. 3-6. Of course, this must be done after the receiver has been laid on the hook, in order to prevent disturbances.

However, this procedure is not always practicable. For instance, in some networks telephone numbers are used which consist of two parts, viz. a first part determining the exchange to which the called subscriber is connected, and a second part determining his number with this exchange, local calls being effected by dialing the second part only. The check symbol of the second part will, of course, be different from the check symbol of the complete number, so that different check symbols would have to be used for local and interurban calls. In order to prevent this complication, it is preferable to check both parts separately, so that the check figure wheel 51 will have to be brought back to its initial position after dialing the first part of the number, without laying the receiver on the hook. For this purpose, the checking device may be provided with a push button or similar operating member, by means of which the check figure wheel may be set back without making use of the dial. A preferred embodiment of such a construction is shown in Figs. 9-11 of the drawing.

As shown in Figs. 9 and 10, a push button 71 is provided, which may be pushed down into a guide bush 72 integral with the casing 30. The push button is pressed upwards by a spring 73, and is connected by means of a screw thread with a cylinder 74 extending through the bottom of the guide bush 72. A piston 75 is movable in the

cylinder 74, and is pushed down by a spring 76 accommodated in a recess of the push button 71. The piston 75 is rigidly connected with a cylindrical stop member 77, adapted to be pressed against the rim of the check figure wheel 51.

A toothed rack 78 is rigidly connected with the cylinder 74, and is adapted to engage a pinion 79, which is rotatable around the shaft 50 of the check figure wheel. The pinion 79 is provided with a salient flange 81 enclosing a ratchet wheel 82 fixedly connected with the check figure wheel 51. Pawls 83 (Fig. 11) are attached to the flange 81 and engage the ratchet wheel 82.

The check figure wheel 51 is coupled with the shaft 50 by means of a friction coupling, consisting of a hairpin wire 84 attached to the check figure wheel by a screw 85 and lying in a slot of the shaft 50. Thus, the check figure wheel will be taken along upon rotation of the shaft 50, but it is adapted to slip with respect to the shaft 50 upon setting back by means of the push button. A recess 86 has been provided in the rim of the check figure wheel in such a position that the symbol + appears in the window 52 when the recess 86 is placed opposite the stop member 77.

The operation of the device is as follows. When the push button 71 is pressed down, the piston 75 is taken along by the action of the spring 76, and the stop member 77 is pressed against the rim of the check figure wheel 51. Upon continued movement of the push button, the toothed rack 78 is brought into engagement with the pinion 79, and this pinion is rotated taking along the ratchet wheel 82 by means of the pawls 83, so that the check figure wheel is set in movement. The check figure wheel slips with respect to the shaft 50, so that the latter remains stationary. The movement of the check figure wheel is continued until the stop member 77 snaps into the recess 86 and locks the check figure wheel in its initial position.

Upon releasing the push button, the pawls 83 slide over the teeth of the ratchet wheel 82. The stop member 77 is removed from the rim of the check figure wheel after the toothed rack 78 has been brought out of engagement with the pinion 79. The device is now ready for the next operation.

Although the invention has been explained hereinbefore with reference to some specific embodiments thereof, it is to be understood that many modifications and adaptations of these embodiments are possible within the scope of the invention, as set forth in the appended claims.

We claim:

1. A device for determining a check symbol for a symbol group composed of symbols selected from a given symbol series, comprising a selector for the symbols of said series, adapted for successive selection of the symbols of said symbol group, an indicator having two scales on which a plurality of check symbols are arranged in opposite order, means actuated by said selector for displacing said indicator in alternate directions, the amount of each displacement being characteristic for the selected symbol, and means actuated by said selector for alternately making a portion of one scale and a portion of the other scale visible, a portion of one scale being visible after a displacement of said indicator in one direction, and a portion of the other scale after displacement of said indicator in the other direction.

2. A device as claimed in claim 1, wherein the row of check symbols on each of the said scales contains the symbols of the given series and an additional open space after one of these symbols.

3. A device for determining a check symbol for a symbol group composed of symbols selected from a given symbol series, comprising a telephone type dial for selecting the symbols of said series, an indicator having two scales, on which rows of check symbols are arranged in opposite order, means actuated at each selective movement of said dial for alternately making a portion of one scale and a portion of the other scale visible, a reversible coupling between said dial and said indicator, and means for changing over said coupling after each selective movement of said dial.

4. A device for determining a check symbol for a symbol group composed of symbols selected from a given symbol series, comprising a telephone type dial for selecting the symbols of said series, a toothed wheel coupled with said dial at least during each forward movement thereof, an indicator having two scales on which rows of check symbols are arranged in opposite order, a second toothed wheel coupled with said indicator, a rocking member, two sets of gear wheels carried by said rocking member, being in continuous engagement with said first-mentioned toothed wheel, and alternately engaging said second toothed wheel, according to the position of said rocking member, so as to drive said indicator in alternate directions, means coupled with said rocking member for alternately making a portion of one scale and a portion of the other scale visible, and means actuated together with said dial for changing over the position of said rocking member after each forward movement of said dial.

5. A device for determining a check symbol for a symbol group composed of symbols selected from a given symbol series, comprising a telephone type dial for selecting the symbols of said series, a toothed wheel coupled with said dial at least during each forward movement thereof, an indicator having two scales, on which rows of check symbols are arranged in opposite order, a second toothed wheel coupled with said indicator, a rocking member, two sets of gear wheels carried by said rocking member, being in continuous engagement with said first-mentioned toothed wheel, and alternately engaging said second toothed wheel, according to the position of said rocking member, so as to drive said indicator in alternate directions, means attached to said rocking member for alternately making a portion of one scale and a portion of the other scale visible, a cam on said rocking member, a cam disc engaging said cam so as to determine the position of said rocking member, and means actuated together with said dial for displacing said cam disc over one position after each forward movement of said dial.

6. A device for determining a check symbol for a symbol group composed of symbols selected from a given symbol series, comprising a telephone type dial for selecting the symbols of said series, an indicator having two scales, on which rows of check symbols are arranged in opposite order, a reversible coupling between said dial and said indicator, and a rotatable hook-shaped lever extending into the path of the holes of said dial and actuated at the end of each forward movement thereof for changing over the said coupling, and for alternately making a portion of one scale and a portion of the other scale visible.

7. A device for determining a check symbol for a symbol group composed of symbols selected from a given symbol series, comprising a tele-

phone type dial for selecting the symbols of said series, a toothed wheel coupled with said dials at least during each forward movement thereof, an indicator having two scales, on which rows of check symbols are arranged in opposite order, a second toothed wheel coupled with said indicator, a rocking member, two sets of gear wheels carried by said rocking member, being in continuous engagement with said first-mentioned toothed wheel, and alternately engaging said second toothed wheel, according to the position of said rocking member, so as to drive said indicator in alternate directions, a covering plate carried by said rocking member and alternately covering the said scales, a cam on said rocking member, a cam disc engaging said cam so as to determine the position of said rocking member, a rotatable hook-shaped lever extending into the path of the holes of said dial so as to be taken along therewith at the end of each selective movement of said dial, a spring for returning said lever after release of the dial, a ratchet wheel coupled with said cam disc, and a pawl attached to said lever and engaging said ratchet wheel during the return movement of said lever so as to displace said cam disc over one position, thereby changing over the position of said rocking member.

8. A device for determining a check symbol for a symbol group composed of symbols selected from a given symbol series, comprising a telephone type dial for selecting the symbols of said series, a check symbol wheel on which two concentric rows of check symbols are arranged in opposite order, a covering plate for alternately covering the said rows, a reversible coupling between said dial and said check symbol wheel, and means for changing over said coupling and for displacing said covering plate after each selective movement of said dial.

9. A device for determining a check symbol for a symbol group composed of symbols selected from a given symbol series, comprising a telephone type dial for selecting the symbols of said series, an indicator having two scales on which rows of check symbols are arranged in opposite order, a covering member for alternately covering the said scales, a reversible coupling between said dial and said indicator, means for changing over said coupling and for displacing said covering member after each selective movement of said dial, and a resilient stop member engaging the holes of said dial for preventing a return movement thereof.

10. A device for determining a check symbol for a letter group composed of letters selected from the alphabet, comprising a telephone type dial, along which the letters of the alphabet are arranged in their usual order, followed by an open space marked by an auxiliary symbol, an indicator having two scales each containing the letters of the alphabet in their usual order, followed by an open space marked by an auxiliary symbol, the symbols being arranged on the said scales in opposite order and along closed circles, and the initial positions of the rows of symbols on the said scales being shifted with respect to each other over one position, a covering member for alternately covering the said scales, a reversible coupling between said dial and said indicator, and means for changing over said coupling and for displacing said covering member after each selective movement of said dial.

11. A device for determining a check symbol for a figure group composed of a plurality of digits, comprising a telephone type dial, along

which the digits are arranged in their usual order, an indicator having two scales each containing the digits in their usual order, followed by an open space marked by an auxiliary symbol, the symbols being arranged on the said scales in opposite order and along closed circles, and the initial positions of the rows of symbols on the said scales being in alignment with each other, a covering member for alternately covering the said scales, a reversible coupling between said dial and said indicator, and means for changing over said coupling and for displacing said covering member after each selective movement of said dial.

12. A device for determining a check symbol for a selected telephone number, adapted to be actuated by the dial of a telephone apparatus and comprising a rotatable member coupled with said dial only during each forward movement thereof, an indicator having two scales on which a plurality of check symbols are arranged in opposite order, a covering member for alternately covering the said scales, a reversible coupling between said rotatable member and said indicator and means actuated together with said dial for changing over said coupling and for displacing said covering member after each forward movement of said dial.

13. A device for determining a check symbol for a selected telephone number, adapted to be actuated by the dial of a telephone apparatus, and comprising a rotatable member coupled with said dial only during each forward movement thereof, an indicator having two scales on which the digits from 1 to 0 are arranged in opposite order, followed on each scale by an open space marked by an auxiliary symbol, a covering member for alternately covering the said scales, a reversible coupling between said rotatable member and said indicator, and means actuated together with said dial for changing over said coupling and for displacing said covering member after each forward movement of said dial.

14. A device for determining a check symbol for a selected telephone number, adapted to be actuated by the dial of a telephone apparatus, and comprising a rotatable member coupled with said dial only during each forward movement thereof, a check figure wheel on which the digits from 1 to 0 and an open space marked by an auxiliary symbol are arranged in opposite order in two closed concentric circular rows, a covering member alternately covering the said rows, a reversible coupling between said rotatable member and said check figure wheel, and a hook-shaped lever extending into the path of the holes of said dial and adapted to be engaged at the end of each forward movement thereof to change over said coupling and to displace said covering member.

15. A device for determining a check symbol for a selected telephone number, adapted to be actuated by the dial of a telephone apparatus, and comprising a rotatable member coupled with said dial only during each forward movement thereof, a check figure wheel, on which the digits from 1 to 0, and an open space marked by an auxiliary symbol, are arranged in opposite order in two closed concentric circular rows, a driving shaft for said check figure wheel, a friction coupling between said driving shaft and said check figure wheel, a covering member for alternately covering the said rows, a reversible coupling between said rotatable member and said driving shaft, means actuated together with said dial for changing over said coupling and for displacing

said covering member after each forward movement of said dial, a push button, a stop member resiliently coupled with said push button and adapted to be pressed against the rim of said check figure wheel upon depression of said push button, a toothed rack rigidly attached to said push button, a pinion adapted to be engaged by said toothed rack upon depression of said push button and a pawl and ratchet mechanism for coupling said pinion with said check figure wheel, 10 the said check figure wheel being provided with a recess adapted to engage said stop member in the initial position of said check figure wheel.

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