NEW METHODS FOR THE TRAINING OF RADIOTELEGRAPHISTS AND TELEGRAPHISTS

BY

Dr. R. A. BIEGEL

Psychotechnical adviser of the P.T.T.
Privaatdocent (private lecturer) for psychotechnics
at the Technical University of Delft

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About the author — Dr. Rebekka Aleida Biegel (1886–1943)

Rebekka (Betty) Aleida Biegel was born on 25 July 1886 in Groningen. At the age of forty-one she began a course of study in psychology in Utrecht, and in 1929 she entered the service of the PTT as a psychotechnician. There she built up the Psychotechnical Laboratory, which opened its doors in 1933 and also attracted attention abroad. From 17 October 1935 she was a private lecturer for psychotechnics at the Technical University of Delft, and she was among the first board members of the Netherlands Institute of Practising Psychologists. As a pioneer of applied psychology in the Netherlands she developed assessment and selection methods, some of which remained in use into the nineteen-seventies.

The present work, *New Methods for the Training of Radiotelegraphists and Telegraphists* (1939), stems from this period of her scientific work.

On account of her Jewish origin, Biegel was dismissed from the PTT in 1941. On 26 May 1943 she was seized in a raid and taken to Camp Westerbork, where she died on 1 June 1943: she and her sister put an end to their lives there when deportation to Sobibor was imminent. She was 56 years old.

Sources: Oorlogsgravenstichting (War Graves Foundation), reg. no. 11831 (date of birth and death, grave — verified primarily); R. Roe, "A woman pioneer in Dutch applied psychology: Rebekka Biegel (1886–1943)" (2008) and Wikipedia (career data — secondary)

About this transcription

This is a transcription of the original booklet by Dr. R. A. Biegel, „Nieuwe methoden voor opleiding van radiotelegrafisten en telegrafisten", Waltman Publishers, Delft, 1939 (Psychotechnical Laboratory of the P.T.T.). The original 1939 spelling has been deliberately retained in the Dutch source („teeken", „gehoor", „opnemen", etc.); only clear scanning/OCR errors have been corrected. Some tables have been transferred in simplified form to improve readability.

About the method described

The methods described in this book were not theory alone. Biegel designed and tested them in the Psychotechnical Laboratory of the P.T.T. in The Hague, and according to her foreword they had already been introduced in 1939 in the training of radiotelegraphists and telegraphists at the Aviation Department at Soesterberg, the Naval Coastguard in Amsterdam and the Radio and Signals Service of the Navy. Her starting point — teaching sending and receiving through the rhythm and sound of the sign, instead of through the mechanical counting of dots and dashes — anticipated an insight that would become generally current only much later, in the computer age. The German invasion of May 1940, however, put an end to precisely those services where her method had been introduced; her dismissal in 1941 and her death in 1943 then deprived the work of its advocate. Dutch professional training subsequently remained stuck for decades on the older counting method, so that her early, empirically grounded approach largely fell into oblivion.

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CONTENTS

Foreword..... 5
CHAPTER I — Receiving by ear
§ 1. Introduction..... 7
§ 2. Material for receiving by ear..... 10
§ 3. The teaching of receiving by ear..... 15
§ 4. Advantages and disadvantages of the new method..... 22
§ 5. Aptitude for receiving by ear..... 24
§ 6. Errors made in receiving by ear..... 26
CHAPTER II — Sending with the Morse key
§ 7. Introduction..... 29
§ 8. Material for sending with the Morse key..... 30
§ 9. The teaching of sending with the Morse key..... 33
§ 10. Aptitude for sending with the Morse key..... 40
CHAPTER III — Receiving lamp signals
§ 11. The teaching of receiving lamp signals..... 42
§ 12. Aptitude for receiving lamp signals..... 42
TABLES

FOREWORD

The new training methods for receiving by ear and for Morse sending (the latter also usable for receiving lamp signals) were designed and worked out by me in the Psychotechnical Laboratory of the P.T.T. in The Hague.

The definitive forms came about after extensive experiments in this laboratory and after application in practice.

The methods have been introduced in the training of radiotelegraphists and telegraphists at the Aviation Department at Soesterberg, at the Naval Coastguard in Amsterdam and at the Radio and Signals Service of the Navy in Amsterdam. The possibility of introduction in other services is under study.

Many a man from practice will find it somewhat strange that a psychologist has occupied herself with drawing up training methods in the field of radiotelegraphy and telegraphy. He will perhaps think that this ought to be done by someone who has given instruction in this field for years.

One must not forget, however, that learning is a psychological process and that, for the presentation and processing of any subject matter, methods must be drawn up that take account of the peculiarities of this process. The most obvious or the most commonly applied methods are not always the most correct. In many a field the psychologist can still do useful work by indicating methods according to which the subject matter ought to be built up.

This booklet gives a survey of the psychological principles on which the above-mentioned methods rest. Furthermore it is a manual for the application of the methods.

Heads of training institutes and courses who wish to obtain the complete material (texts and punched tapes) needed for the instruction may apply for information to the author of this booklet.

The automatic sending keys for training in Morse sending can be supplied by the firm Ridderhof and van Dijk in Zeist.

R. A. BIEGEL.

The Hague, June 1939.

CHAPTER I

RECEIVING BY EAR

§ 1. Introduction

A radiotelegraphist who receives by ear must, after he has heard a sign, make a choice among the Morse signs that come into consideration (at most 61). After that he must record his choice by writing down the chosen sign or by striking a particular key of a typewriter.

Skill in choosing quickly and recording quickly can be acquired only after long practice. The maximum number of signs that must be recorded per minute is internationally fixed for the radiotelegraphist's diploma of the 1st class at 125 (25 wpm).

A pupil radiotelegraphist can only begin by taking few signs per minute. This low tempo can be obtained in various ways. In general it is customary to give the signs in slowed-down (stretched) form, and also to lengthen the pauses between the signs. If an automatic Creed transmitter is used in the instruction, signs and pauses are slowed down to the same degree by letting the punched tapes run through slowly. If sending is done by hand, the pauses are often lengthened a little more than the signs.

If the training takes place in one of these ways, then, as the tempo is raised, both the signs are gradually given faster and the pauses are shortened. The signs thus change continually during the training. For the first while they are heard as combinations of dots and dashes, of which every dot and every dash is perceived separately. But when a certain tempo — which differs from one individual to another — has been reached, then a sign changes entirely in character; it is perceived as a typical whole, as a sound-image.

The transition from combination to sound-image demands, in the old method, a change of the pupil's attitude towards the material presented. This change costs time and betrays itself in the practice curve through a so-called plateau. For some time the pupil makes no progress; he cannot climb in speed. Only when the new conception has completely supplanted the old can progress be made again.

It is psychologically wrong when, in practising, something is first learned that must later be unlearned again.

These difficulties can be avoided by presenting the pupil with the same sound-images from the beginning to the end of the training. This can be achieved by always giving the signs in the form they have at the chosen final speed, and at the beginning separating them by very long pauses, which pauses are reduced several times by a certain length during the training, until the normal pause is reached. On this principle my method is built up. With the application of this method, therefore, the signs are never heard as combinations of dots and dashes, but always as typical sound-images.

Experience has shown that, with the application of the training method designed by me, the plateaus disappear, because nowhere is a different conception of the material presented required. By this, time is gained; the practice curves have a much steeper course. Further time is gained because one begins with a larger number of signs than in the old method. For a chosen final speed of 16 to 25 wpm one begins with on average 41 signs per minute (8.2 wpm). For a chosen final speed of 12 wpm one begins with 33 signs (6.6 wpm). For further particulars see Table II.

At the first application of the method in the Psychotechnical Laboratory of the P.T.T., 2 subjects H and J were trained. The training comprised 40 signs. The results of the new training method have been compared with those of the old method, according to which a large number of pupils had been trained at the Telegraph Office in Amsterdam. The selection in this training was very strict; 65 % of the pupils were dismissed, so the remainder were without exception of very good quality. The duration of

the training according to the old method varied from 189 to 405 hours; the greater part of the pupils had a training duration of about 297 hours. In Fig. 1 the results of the old and new training methods are shown.

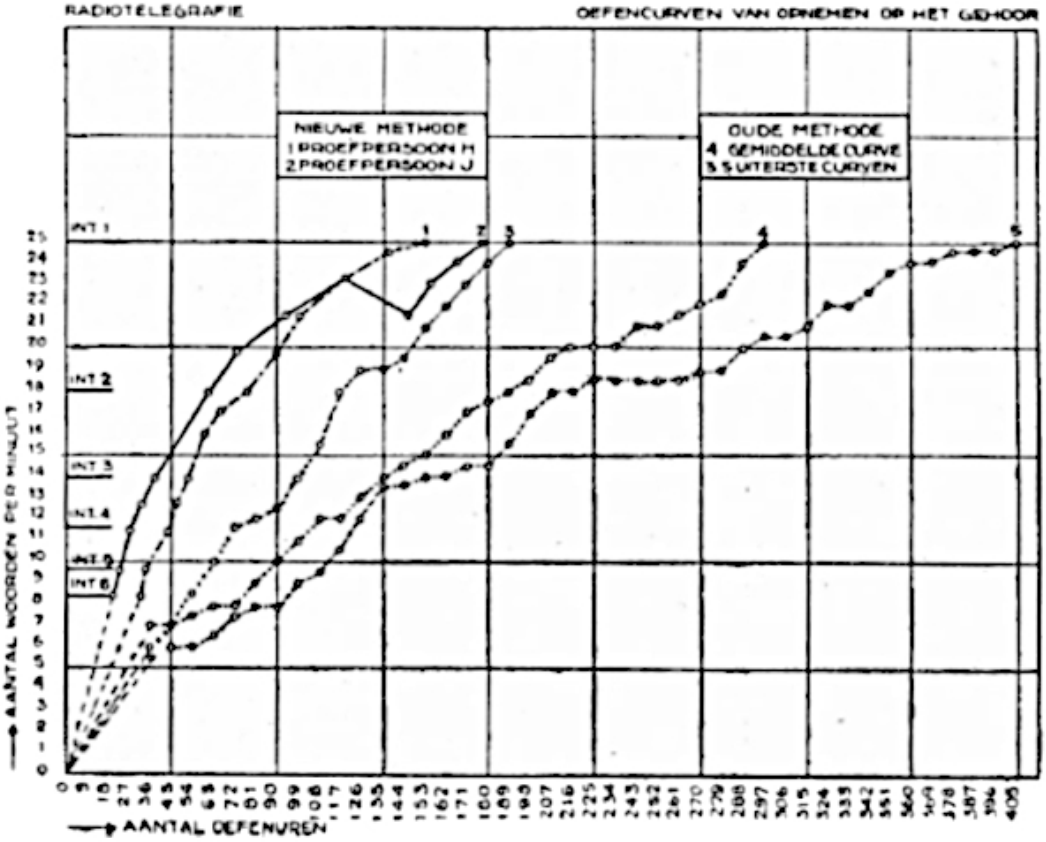


Fig. 1. Results obtained with the new training method for receiving by ear.

The time saving with the application of the new method may be put at about 40 %.

§ 2. Material for receiving by ear

In the instruction use is made of an automatic Creed transmitter, of a lamp buzzer and of tapes punched on the Creed punching box.

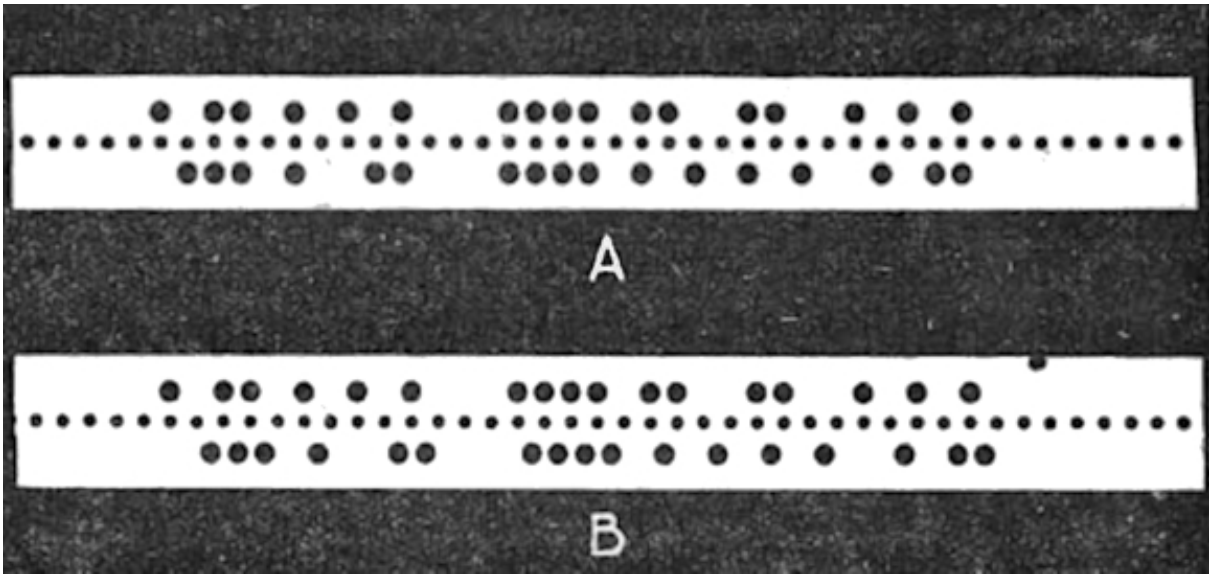
The punched tapes run through the Creed transmitter at the same speed throughout the whole training. This speed is determined by the final speed one wishes to reach.

At the end of the training one gives series that are punched normally (further indicated as: interval 1), that is to say that if the dot = 1, the dash = 3 and the interval between parts of a sign = 1, then the interval between the signs = 3 and that between the words, obtained by pressing the space key once = 7. This last is not generally known; the Creed transmitter gives a word interval that is 2 units longer than interval 5 in hand sending.

At the beginning of the training, therefore, only few signs per minute are presented; these signs are separated by large intervals, obtained by pressing the space key several times. If the space key is pressed once, then we get between the signs the letter interval that arises automatically + 1 space; we then speak henceforth of interval 2. Interval 2 is thus equal to the word interval. At interval 3 the space key is pressed twice, and so on. It has proved necessary to have material with interval 1½ as well. At interval 1½ one gets between the signs the letter interval that arises automatically + ½ space. One can obtain ½ space by making use of the reduction key.

It is necessary that at the beginning of the training the pupil should have a time span of about 1 sec. between the signs in order to be able to make his choice and to write down the chosen sign. With a fast-running tape, e.g. final speed 20 wpm, one must press the space key more often to obtain a time interval of 1 sec. than with a slow-running tape (12 wpm). For every chosen final level there is therefore a particular starting interval, which is gradually reduced. The following calculation may show how one arrives at the determination of the starting interval.

At a speed of 25 wpm a piece of tape runs through the Creed transmitter per minute whose length is equal to 632 current reversals or „reversals". The length of a reversal is equal to the little piece of tape from a particular hole of the feed to the next one.



[Fig. 2] Writing obtained with the Creed punching box: A as it is produced, B as it must be read. Fig. 2A shows the punched words „DEN HAAG"; the letters of each word are punched normally one after another, the word interval being obtained by pressing the space key once.

The buzzer tone arises because, through a contact via each punched hole in the upper row, a current is closed which is broken again by a contact via the corresponding or following punched hole in the lower row. Between the upper row of punched holes and the lower row, however, there exists a phase difference equal to half the time needed to run through the interval between 2 feed holes (1 reversal). What one hears is therefore what is shown in Fig. 2B.

One sees from Fig. 2B that indeed, as was said at the beginning of this §, if one sets the distance of 2 feed holes = 2:

	Length		*Length*
dot	1	int. between parts of a sign	1
dash	3	int. between signs	3
space	4	word interval	7

Expressed in reversals this is:

	Length (rev.)		*Length (rev.)*
dot	½	int. between parts of a sign	½
dash	3½	int. between signs	3½
space	2	word interval	7½

Pressing the space key lengthens an interval by 2 revs. It is possible to lengthen an interval by 1 rev. by making use of the reduction key.

From the length of the piece of tape run through at a speed of 25 wpm, the number of revs. run through per minute at other speeds can be calculated. This number is, respectively, for:

	25 wpm	*20 wpm*	*16 wpm*	*12 wpm*
revs. per minute	632	506	404.5	303
duration of 1 rev. (sec.)	0.095	0.120	0.148	0.198

These values enable us to calculate the lengths of a normal interval and of lengthened intervals, and the average length of a sign at a particular speed.

In Table I the calculation has been carried out for 20 wpm. We see from this Table that we must go to interval 4 to obtain a pause between the signs that lies in the neighbourhood of 1 sec. At this pause, 45 signs are given per minute. At int. 3 the number of signs becomes 55, at int. 2 it rises to 71, at int. 1½ it becomes 83, to reach 100 at int. 1 (20 wpm).

The calculation can be carried out in the same way for the higher speed of 25 wpm and for the lower ones of 16 wpm and 12 wpm. The result of all the calculations is summarized in Table II.

We see from this Table that, if one chooses a final speed of 25 wpm, one must begin with int. 6. At the final speed of 20 wpm one begins with int. 4, at 16 wpm likewise with int. 4, and at 12 wpm with int. 3. Depending on the choice of the final level, the first part of the punched material is therefore different; at the end of the training the material is the same for all final levels, but it then runs through the Creed transmitter at different speeds. The training that leads to 25 wpm is naturally the longest and comprises 7 stages; the training that leads to 12 wpm comprises only 4 stages. For 20 wpm and 16 wpm final speed the same material is used.

In the method designed by me, the pauses between the signs are shortened in jumps; the pause decreases either by 2 revs (1 space) or by 1 rev (reduced space). At every jump-wise shortening of an interval there likewise occurs a jump-wise increase in the number of signs per minute. At the final speed of 12 wpm this jump (see Table II) is at most 10 signs per minute, at final speed 16 wpm at most 13 signs, at 20 wpm at most 17 signs, at 25 wpm at most 22 signs. Every jump naturally gives rise to an increase in the number of errors, which, however, usually disappear again within an acceptable time.

It has appeared that at the final speed of 25 wpm the largest jump, of 22 signs, at the transition from interval 1½ to int. 1, was troublesome in connection with the already attained high speed, so that the pupil had to practise on the final level for a long time. This had a depressing effect. Therefore the method, originally designed for final speed 25 wpm, is nowadays applied only for final speed 20

wpm. If further ascent is still necessary, one can climb to 25 wpm in the old way, by gradually increasing the speed of the running tape.

It is true that at the end of the training the same material is used for all the different final levels; one must not, however, lose sight of the fact that practising at int. 3 at final speed 20 wpm is not the same as practising at int. 3 at final speed 12 wpm. For in the first case 55 signs are presented per minute and every pause is short; in the second case 33 signs are presented per minute and every pause is long. The higher the chosen final level, the longer, accordingly, one must practise at each interval.

Table III gives the schema of the arrangement of the practice material for a chosen final speed of 20 wpm. The series are indicated by the letters Z.E. and a number; they are series for buzzer instruction, drawn up in accordance with the international regulations, including the amendments made by the Telegraph Conference at Cairo in 1938.

I shall return in detail to the arrangement of the schema in § 3. The number of series for each interval must be so large that, in practising, the pupil hears each series only a few times. Otherwise he would run the risk of still remembering passages. The number of series needed for each interval at a given final speed has been established experimentally. For a chosen final speed of 20 wpm, therefore, a total of 410 punched series are needed. At a final speed of 25 wpm the number of series at each interval would not be large enough. At a final speed of 12 wpm the number 410 is far too large: one can then make do with a total of 190 series.

§ 3. The teaching of receiving by ear

The series of the schema of Table III can be divided into two parts, the series 1—65 and the series 66—410. The first part consists of the so-called learning series. These learning series serve to make the pupil familiar with all the signs in as short a time as possible. The second part, from series 66 onward, comprises the so-called practice series; these serve to keep raising the tempo until the final tempo is reached.

The arrangement and the texts of the learning series 1—65 are the same for all final speeds. They are, however, punched differently according to the chosen final speed. At final speed 20 wpm, on which Table III is based, they are punched with int. 4.

For training according to the international Telegraph Regulations (Cairo revision of 1938) a total of 61 signs must be taught. These are indicated in Table IV. In Table V the division into groups followed in the training is indicated. If all signs, including the abbreviated numerals, are taught, there are in total 65 learning series.

At the beginning of the training every pupil should be put in possession of Tables IV and V and should know the signs as soon as possible as sound-images, that is to say, on seeing a letter he must react with a sound-image, e.g. a = dida, p = didadada, sung in the way in which the lamp buzzer makes these signs heard.

The groups are composed of signs that resemble one another very closely and that can therefore easily be confused with one another. In contrast to the arrangement of other training methods, no signs that are each other's mirror image have been combined here, because confusion of such signs hardly ever occurs with the method I follow. The majority of the errors are made by confusion of signs that differ from each other by only 1 dot (u and v, b and 6). To a lesser degree, confusions occur of signs where in the one a dot stands where in the other a dash occurs (j and p). The definitive arrangement was established after extensive experiments in which all the pupils' errors were analysed.

In Table V the first groups of signs are presented in series 1 and 2; the following groups are given in series 4, 6, etc. As an example of the composition of these group series, the series Z.E. 8 is reproduced in Table VI. (Vrg means: error sign.)

The series consists of 1 block of 6 and 3 blocks of 4 lines. The first block begins with 4 lines, each consisting of 10 times one of the new signs. The last 2 lines of block 1 and all lines of block 2, in total 60 signs, are composed of all the new signs, each sign being represented equally often. (In group series in which only 3 new signs are taught, the first block begins with 3 lines of identical signs; these are again followed by two lines with the new signs mixed; the first block then consists of 5 lines.)

Block 3 consists for 75% of new signs, for 25% of all the signs that were taught before series 8, all the old signs being represented equally often. Block 4 consists for 50% of new signs, for 50% of all the signs that preceded series 8.

Every group series is followed by a mixed series. The mixed series are indicated in Table V only by a number. On Table VI the mixed series Z.E. 9 is shown. A mixed series consists of 4 blocks of 4 lines. In the mixed series the new signs are evenly mixed with the old.

The pause after each line is a little more than twice the letter interval; the pause between the blocks is a little more than three times the letter interval. Complete equality is impossible, since the automatically arising letter interval = 3½ rev. and 1 space = 2 revs.

The intention is to teach all the signs in as short a time as possible. To this end one adds a new group in each practice hour at the beginning, that is to say, in the first practice hour one gives only series 1, in the second practice hour series 2 is added, in the third practice hour series 4, in the fourth series 6, etc. Finally it is not possible to give all the groups one is working with in every practice hour. One must then, by keeping a record, see to it that all group series are given regularly.

The first time one presents a group series, one begins by telling the pupil, with the aid of Table V, which signs are to be taught. After that one lets him hear the lines with identical signs once, without his having to write anything down. After that one gives only the first 2 blocks, that is, the new signs alone and not mixed with the old. The next time the series is presented, one again gives only the first 2 blocks, and this is continued until the new signs are taken almost without errors (maximum 2, with difficult groups 3 errors). One corrects only the 6 lines in which the new signs are mixed, thus 60 signs in total. 2 errors correspond to a good 3%, 3 errors to 5%. Difficult groups are given in series 2, 6 and 31, easy groups in series 10, 12 and 16. Every wrongly received or missing sign counts as 1 error.

If the new signs in the first 2 blocks are taken almost without errors, one proceeds to give the whole series, thus all 4 blocks. One then corrects, however, only the last 2 blocks. The maximum number of errors that is permissible is 3 in 80 signs (almost 4 %).

When the last 2 blocks are received with no more than 3 errors, one can drop the group series and proceed to the following mixed series. Usually this is then taken almost without errors after 1 or 2 times. Of the mixed series one corrects 2 blocks; the greatest number of permissible errors is again 3.

One must emphatically be warned against proceeding to the last 2 blocks of a group series while the first 2 are not yet mastered, or against proceeding to a mixed series while the last 2 blocks of the preceding group series, or the previous mixed series, are not yet mastered. This gives no saving of time, but great loss of time; the pupil cannot master the material presented and becomes confused.

The instruction is given in this way up to and including series 22, with series 29, 31 and 33 (punctuation marks) immediately following on. Series 23 and 24 (numerals only) can be given only when the first halves of the series up to and including 20 are taken well. Since the numerals are then already known, series 23 and 24 may be regarded as a revision. Series 25 and 26 can be presented only when the numerals are mastered, while the mixed series 27 and 28 can follow only after that. It could therefore happen that series 29, 31 and 33 were already fully mastered, but the mixed series belonging to them could not yet be given, because fractions occur in them. As soon as an instructor has acquired some practice with the method, however, he will take care to set the dosage of series 29,

31 and 33 in such a way that they are just mastered by the time one reaches the mixed series 30. The above seems very complicated, but in practice it proves to be very simple.

The last ordinary mixed series is 34. Series 35 up to and including 49 are intended to consolidate the foregoing; they thus contain all letters, numerals and punctuation marks, and fractions occur in them too. An example of these revision series is given in Table VII. In these series the division into blocks has been dropped; the series are also longer than the preceding ones. All this serves to accustom the pupil now to receiving for longer stretches without interruption. For the correction of these revision series, what will always apply later in the training holds: the number of errors must have sunk to 1% at least once before one may proceed to the next interval. In counting the number of errors, again every wrong or omitted sign is counted as 1 error. From the given series, which are now all equivalent, one corrects arbitrary passages, e.g. up to a total of 30 lines. The transition to a faster tempo may, however, take place only when one has the impression that the pupil has not received with 1% errors by chance. If, for example, in the preceding lesson the number of errors was still 4%, then it cannot be assumed that the pupil masters the material. The approach to 1% must have taken place gradually.

By means of series 50–60 the service signs are taught, by means of series 61–65 the abbreviated numerals. Both groups stand on their own; one begins to present them as the training of series 1–49 is drawing to a close.

Series 50 consists exclusively of service signs. In series 51–61 (see example in Table VIII) these service signs are mixed with all the preceding signs. The intention is that the pupil writes down the service signs as an abbreviated word, e.g. for the understood sign "und.". For the closing sign + can be written down. In order to give the pupil time to write down the abbreviated words, a pause is given after each service sign equal to the time needed for 4 service signs with the interval belonging to them. The little crosses in these series indicate this long pause. In a number of lines of series 51–60 there occur 1 or 2 service signs; the remaining places are filled up with other signs. As the exercises for the service signs stand on their own, so they must also be judged separately as satisfactory or unsatisfactory. In the first place attention must be paid to the number of errors in the service signs. If no more errors occur in these, then 2 % errors in the other signs are permissible. Series with service signs of the same construction as those indicated in Table VIII recur at every interval of the training.

The series for abbreviated numerals, series 61–65, also stand on their own. They can be taught as soon as series 25–26 are mastered. Series 61 and 62 do not yet contain fractions, series 63–65 do. Series with abbreviated numerals of the same construction as series 63–65 recur at every interval of the training. The limit for transition to a higher tempo is, for the series with abbreviated numerals, 1 % errors.

When the learning series are fully mastered (1 % errors in one of series 35–49, 2% errors in one of series 51–60, 1% errors in one of series 62–65), one can proceed to the next level. At the final speed of 20 wpm this level is indicated by interval 3. We shall continue to treat Table III as an example.

Interval 3 comprises mixed series of the same construction as series 35–49, further a number of so-called „texts", of which an example is given on Table IX. These texts are composed of passages of text in various languages, in which punctuation marks have been inserted. The difference from the mixed series is that the texts no longer contain all the signs in equal number, further that the division into groups of 10 signs (lines) disappears and instead words of varying length occur, separated by the word interval. The word interval is about twice as long as the letter interval. The examples for the texts have, for the purpose of correction, been divided by vertical strokes into passages of 100 signs.

The series and the texts have been taken into the schema two at a time alternately; it is, however, advisable to give only series in the first hours, until the pupil gets used to the higher tempo, and to

give the texts only after that. Furthermore, interval 3 again comprises series with service signs and series with abbreviated numerals.

When this level too is mastered (the percentage of permissible errors was indicated at the previous interval), one proceeds to interval 2. At this level the mixed series disappear for good, and with them the even distribution of all letters, numerals and punctuation marks. The texts still remain. Alongside these, the „telegrams" appear for the first time, of which an example is given on Table X. These are series consisting of telegrams in various languages and in code. They are closed by the cross sign. By this the pupil is gradually made familiar with the receiving of material that occurs in practical service. The series with service signs and abbreviated numerals recur at this interval too. When interval 2 too is completely mastered, one proceeds to interval 1½. Here only telegrams are still given; the texts have disappeared.

After interval 1½ comes interval 1. Here the telegrams are punched in the normal way. When the pupil masters the series with interval 1, he can receive 20 wpm. The requirement of 1% errors for telegrams and for abbreviated numerals, and of 2% for series with service signs, is maintained to the end.

Only at interval 1 does a splitting of telegrams into „plain language" and „code" follow. By this it becomes possible for the pupil, only at the end of the training, to make suppositions about the letters and words still to come (so-called anticipating). In contrast to what is usually assumed, I have gained the experience that taking code telegrams is easier than taking plain language.

In the foregoing Table III has been treated, and thus a chosen final speed of 20 wpm has been assumed. It seems desirable to me to set out the course of events briefly once more for a final speed of 12 wpm, where one begins with interval 3. The learning series are thus constructed with this interval. Further the development is as follows: interval 2 comprises both mixed series and texts and telegrams, to be presented in succession; interval 1½ and interval 1 comprise only telegrams.

As regards the number of practice hours, it has appeared advisable, at the beginning of the training, until the learning series are completed, to have practice for 2 hours per day, of which 1 hour in the forenoon and 1 hour in the afternoon. After that one can proceed to 1 hour per day.

One must not have practice for a whole hour at a stretch, but at the beginning, until the learning series are completed, insert 3 pauses of 3 minutes; after that 2 pauses of 3 minutes suffice.

If a training consists of receiving by ear and sending with the Morse key, and 2 hours are available for it, then one can begin with receiving only and make 1 hour per day available for sending later.

If the receiving of lamp signals is also taught, it is desirable to begin with this only after a skill of 8 wpm has been reached with 1 hour of practice per day for sending.

§ 4. Advantages and disadvantages of the new method

In § 1 of this chapter some advantages of the new method have already been enumerated. The training is shortened for the following reasons:

a. the signs remain unchanged from the beginning to the end of the training.

b. the plateaus of the practice curve disappear.

c. one can begin at a higher starting speed.

There is, however, yet another advantage, namely

d. the pupils split, already after a few hours, into groups of greater and lesser ability. I shall return to this ability in § 5.

Honesty obliges me to mention that the new method also shows some disadvantages, against which, however, in my opinion, the advantages amply outweigh. The first disadvantage, which is, however, only temporary, is the great amount of correction work that is necessary at the beginning of the training. Continually, with every group series and mixed series, one must check whether it is already mastered.

The second disadvantage is that the pupil, before he has reached interval 1, cannot receive normally sent material. For institutes and courses that require the pupil to be usable already „along the way", and able to receive slowly sent material, it is not desirable to choose a high final level. One then does better to choose the final level 12 wpm, which can be reached in a short time, and then to continue according to the old method, that is, the material with interval 1 is used further, the punched tapes being run faster and faster through the Creed transmitter. In this way, however, one exploits the advantages of the new method only partly. For gifted pupils it is therefore always advisable to choose a high final level.

The fact that a pupil who is trained directly for the level 20 wpm does not pass through the normal level 12 wpm and 16 wpm has sometimes made some people fear that this pupil would later, in practice, be unable to take material at a tempo lower than 20 wpm. This has proved to be incorrect. Once the pupil has learned to take 20 wpm, one can, by slowing down the speed of the tapes in the Creed transmitter, accustom him in a few hours to taking material at a lower tempo as well.

§ 5. Aptitude for receiving by ear

In general one can say that an arbitrary group of pupils comprises:

about 25 % very good pupils, who are very gifted and can learn receiving in a short time.

about 25 % pupils who still learn receiving without difficulty.

about 25 % pupils who can still learn receiving, but with difficulty and after a long time.

about 25 % pupils who never learn to receive well, because they lack any aptitude in this field.

As for every activity, it is advisable here too to subject the pupils beforehand to a psychotechnical examination.*) One can then, with great certainty, sift out the last group, and if desired the last but one group as well, and divide the pupils from the outset into classes according to their ability.

If one will not or cannot proceed to a preliminary psychotechnical assessment, then the new training method makes a division according to ability possible. Already after a few practice hours it appears, with absolute certainty, from the number of errors made, to which group the pupil belongs. The spontaneous splitting into groups proves to be entirely constant, although an indifferent or lazy pupil may sometimes perform less well than he actually can, and a very diligent pupil may sometimes advance faster than is to be expected from his aptitude. This last, however, is possible only up to a certain point; a deficiency in the very special aptitude needed for the work of a radiotelegraphist cannot be made good even by the best character qualities.

In my opinion the aptitude for receiving is two-sided. On the one hand a certain musical aptitude must be present, namely the power of discrimination for sound-images and a sense of rhythm. On the other hand a certain motor ability must be present, namely the capacity to carry out a movement quickly after the manner of reaction to a stimulus has been chosen on the basis of a mental perception. If the first ability is lacking, one never learns to receive without errors. If, however, the second ability is lacking, one can no longer keep up at high speeds.

For very poor pupils (the last 25 %) the new method is not suitable; even a low final speed, 12 wpm, is unattainable for this group. This level is, however, not attainable with the application of the old method either, but then a level of perhaps 6 wpm can be reached. It is therefore advisable that, as soon as it appears that a pupil belongs to these poor ones and one cannot break off the training, one should

no longer continue with the new method and should return to training according to the old method with a very low starting speed (4 wpm).

For the pupils who have just barely sufficient aptitude (the last but one 25 %) one can, with the new method, aim at most at a level of 12 wpm. They still need quite a lot of time, however, to reach this.

For the first and the second 25 %, thus for the very good and the sufficient pupils, one can aim immediately at a level of 16 or 20 wpm. The very good ones, however, can reach this level much faster than the second group.

When one has headphones and more than 1 Creed transmitter at one's disposal, one can teach a class of pupils simultaneously and yet split the pupils into groups that each develop according to ability. One instructor can easily operate up to 3 Creed transmitters at once. This operating consists only in inserting the punch tapes that are due.

**) There is an opportunity for this in the Psychotechnical Laboratory of the P.T.T., Kortenaerkade 12, The Hague.*

§ 6. Errors made in receiving by ear

As was said in § 5, the pupils split, already after a few practice hours, into groups of better or poorer aptitude. This aptitude appears in the first place from the number of errors the pupils make, but also from the nature of the errors and from their grouping. A lack of aptitude for distinguishing sound-images and for rhythm shows itself in the confusion of signs; a lack of motor aptitude in the failure to keep up, in the occurrence of gaps of more than 1 sign.

For very gifted pupils (the first 25%) the sound-images are so different that confusion, once one knows the signs, is excluded.

With the next 25%, no confusions occur with most of the signs; there are, however, signs that resemble one another closely (s and h, u and v) that give rise to errors.

With the next 25% after that, errors are made at the beginning with practically all the signs, which, however, can for the most part be overcome. These pupils never learn to receive entirely without errors; the difficult signs remain difficult. The training lasts a long time; a high speed is usually not to be reached.

The last 25 % are so unfitted that, as already said, it is advisable to break off the training for this group as soon as possible.

There are thus signs that, more than others, give rise to confusions. The errors that are made in this are general errors. Often, however, personal errors also occur, among them very strange ones through confusion of signs that do not resemble one another, but for which a wrong association has simply been fixed. With both kinds of errors one can bring about a great improvement by having the pupil listen intensively while a little tape runs through the Creed transmitter on which only the signs that are confused are punched alternately. By gluing the ends of the little tape together one can let a series of indefinite length be heard.

It is advisable from time to time to „tally" the errors made by the pupils. One then sees which of the general errors and which personal errors occur with each pupil.

It is of great importance that it be impressed on the pupil from the beginning that it makes no sense to want to correct errors once written down. As soon as a choice has been made, the pupil must concentrate on the next sign. If he cannot let go of the preceding sign, if he wants to revise the choice already fixed, then the consequence is that the next sign, sometimes a series of following signs, is taken with errors or even missed.

It is easy to convince the pupil, with the aid of the material he has produced, that a corrected error is the cause of one or more other errors. The pupil must learn to regard a choice once made as

irrevocable. It is therefore advisable to give as much code writing as possible, and if one gives intelligible language, to insert in it from time to time an error in a known word, e.g. a place name. With pupils who cling very stubbornly to the correcting of errors, one can proceed to count corrected errors as not corrected.

At the beginning of this § I spoke of the gaps that occur as a result of a lack of motor aptitude. This deficiency comes to light already at the beginning of the training. If the pupil is tested, it betrays itself already in the test examination, whereby insufficient results are obtained.

It may, however, be that a pupil who keeps up well at the beginning suddenly encounters difficulties at a higher speed and produces work with gaps. It is then possible that this occurs because the pupil has no routine in fast writing; he may thus by nature react quickly in a motor sense, but he is not practised in fast writing. The degree of practice is closely connected with the schooling enjoyed; pupils of secondary schools, for example, all have a certain skill in fast writing, pupils of trade schools, who have devoted themselves above all to neat and clear handwriting, usually write slowly. If one wishes to advance with the pupils to the taking of 20 wpm and above, it is advisable, already at the beginning of the training, to give a dictation now and then, in which the text is divided by strokes into groups of 20 signs and in which, with the help of a stopwatch, the speed is gradually increased. For a final speed of 20 wpm (100 signs per minute) a speed in ordinary dictation of at least 160 letters per minute is needed; for 25 wpm it is necessary to go up to 200 letters per minute in the dictation.

CHAPTER II

SENDING WITH THE MORSE KEY

§ 7. Introduction

In the teaching of sending with the Morse key, the pupil must make the correct rhythmic movements of the wrist his own. Morse writing consists of dots, dashes and pauses. If one sets the dot equal to 1, then the dash is equal to 3, the pause between parts of a sign equal to 1, the pause between signs equal to 3 and the pause between words equal to 5. There are thus periods of giving that are equal to 1 and 3, and pauses that are equal to 1, 3 or 5.

The only thing the pupil has to learn is thus, in giving, to observe the correct duration 1 or 3, and in the pauses the correct duration 1, 3 or 5.

This seems very simple, but it is not. The reason for this is that the parts of each sign influence one another. Psychologically this is very well explicable; the parts of a sign — dots, dashes and pauses — together form a particular unit, a „Gestalt". As parts of that unit they are different from what they would be if they were experienced on their own.

If the pupil sends a particular sign, e.g. the letter v (•••—), then the third dot is usually sent too short. With the r (•—•) the dash is usually shortened. One can thus assume that everyone who begins sending does so irregularly, because he, influenced beforehand by the motor unit he wants to send, does not reproduce correctly the parts of which the unit consists. The pupil must now learn to send, not in such a way that it feels right to him, but in such a way that what is written down by the Morse apparatus shows dots, dashes and pauses of the correct length.

At the beginning of this paragraph it was said that the pupil must make the correct rhythmic movements of the wrist his own. It is therefore indicated that in the instruction one should address oneself directly to the wrist, or rather to the kinaesthetic sense which must guide the movements of the wrist; the pupil must learn correct sending through the wrist. It is therefore not correct to call in the intellect together with the hearing, as one does in the ordinary teaching method, in which one tries to instil the correct rhythm in the pupil by counting. This method would be objectionable for the very reason that, by counting, one splits an experience 3 or 5 into 3 or 5 units respectively. Psychologically speaking, 3 is not 3 × 1 and 5 is not 5 × 1.

In the method drawn up by me the instruction is indeed given through the wrist. For each sign the pupil is made to feel how this combination is sent correctly. One thus appeals neither to the intellect (counting) nor in the first place to the hearing — although the hearing too plays a part in my method — but to the kinaesthetic sense.

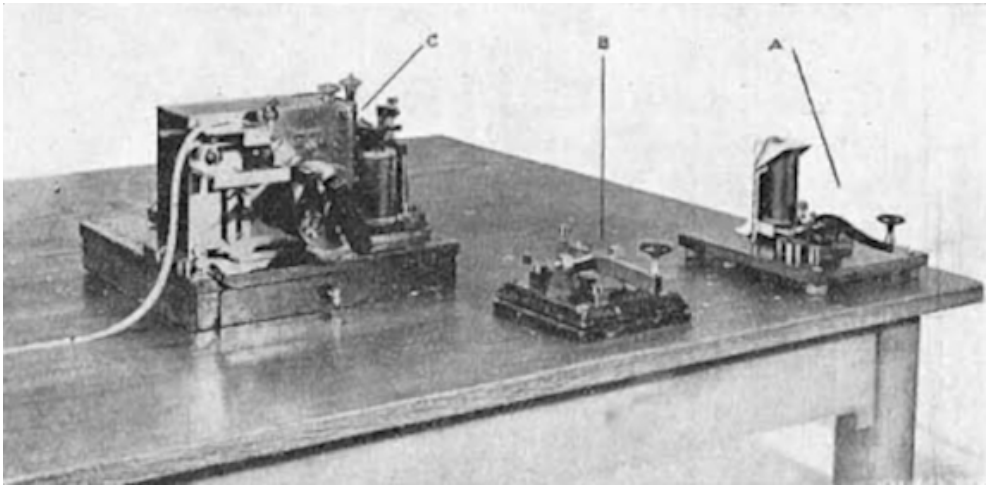
This method of training is possible if one provides every pupil with a sending key that can send automatically. This automatic sending key serves as instructor. The pupil learns the correct method of sending by feeling how the automatic sending key sends. From the above it follows that he will have the impression that it sends irregularly. The only thing he has to learn is to send exactly as the automatic sending key does.

§ 8. Material for sending with the Morse key

In the instruction use is made of a Creed transmitter and of punched tapes. Furthermore every pupil must be provided with an automatic sending key, an ordinary sending key, a Morse apparatus and loose-leaf booklets with the texts that are sent ahead.

The automatic sending key can be connected by a switch with the Creed transmitter in such a way that, as a punched tape runs through, the key sends what is on the tape. The automatic key is mounted next to the ordinary sending key, which is connected in the ordinary way with the Morse apparatus.

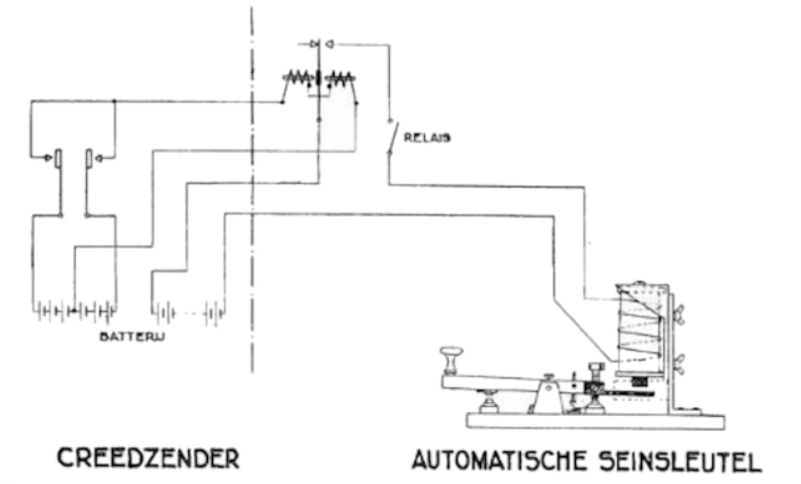
Figure 3 gives a photograph of the set-up for 1 pupil; figure 4 gives a schema of the construction of an automatic sending key and of the way in which it is connected with the Creed transmitter.



[Fig. 3] Teaching installation for 1 pupil. A. Automatic sending key. B. Ordinary sending key. C. Morse apparatus. (photo)

In the teaching of sending with the Morse key too, one must begin with a slow tempo. Since, however, with sending by the Morse key what matters is the correct rhythm, here — in contrast to the buzzer training — no lengthened letter and word pauses may occur; from the beginning all the parts must be given in the correct proportion. One must therefore here, from the beginning to the end, work with tapes that are punched in such a way that they reproduce hand-sent writing entirely correctly. These tapes must run through the Creed transmitter slowly at the beginning of the training, faster later on.

In § 2 it has already been explained that by ordinary punching on a Creed punching box one does not get tapes with word interval 5, but with word interval 7. It is therefore necessary, in the teaching of sending with the Morse key, to use punch tapes in which the word interval has been shortened to 5. This is possible by making use of the reduction key in punching. On striking the last letter of a word, one also presses the reduction key; one keeps this key pressed while one strikes the space key twice and then the first letter of the following word.



[Fig. 4] Construction and circuit schema of the automatic sending key.

At the beginning, one lets the punched tapes run through the Creed transmitter at a speed of 8 wpm; this is thus the starting tempo, which is much higher than in the old method. This tempo is fast enough not to tempt the pupil to count after all, and slow enough to make all the indications of the correct

tempo perceptible to him. Experience has taught that along this way it is possible to have a pupil produce very good and regular sending writing after about 30 hours at a speed of 8 wpm. Once this speed is mastered, one proceeds to higher tempos by letting the tapes run through the Creed transmitter at ever greater speed, climbing by 1 wpm.

From the beginning to the end one thus uses punched tapes with normal letter interval and normal word interval 5. At the beginning and at the end of the training one can thus use the same punch tapes, which only run much faster through the Creed transmitter at the end.

From this it follows that for sending training far fewer series are needed than for the buzzer training. One can, if one does not go higher than 16 wpm, make do with 100 series.

The schema of the sending training is given in Table XI (S.E. series). If one wishes to go higher than 16 wpm, it is advisable, at the end of the training, in „free sending" (see § 9), to have other texts sent in addition to the series of the schema, because otherwise the same series are sent too often. This is tedious for the pupil and leads to wandering of the thoughts and thus to errors.

§ 9. The teaching of sending with the Morse key

The intention is thus that the pupil learns to send by feeling the perfect method of sending of the automatic sending key.

The material is split into 2 parts: so-called learning series (S.E. 1 — S.E. 70), which serve to make the pupil familiar with all the signs to be sent, and the telegrams following on these (S.E. 71 — S.E. 100), which are, however, used only later in the training. The telegrams consist of groups drawn up alternately in plain language and code.

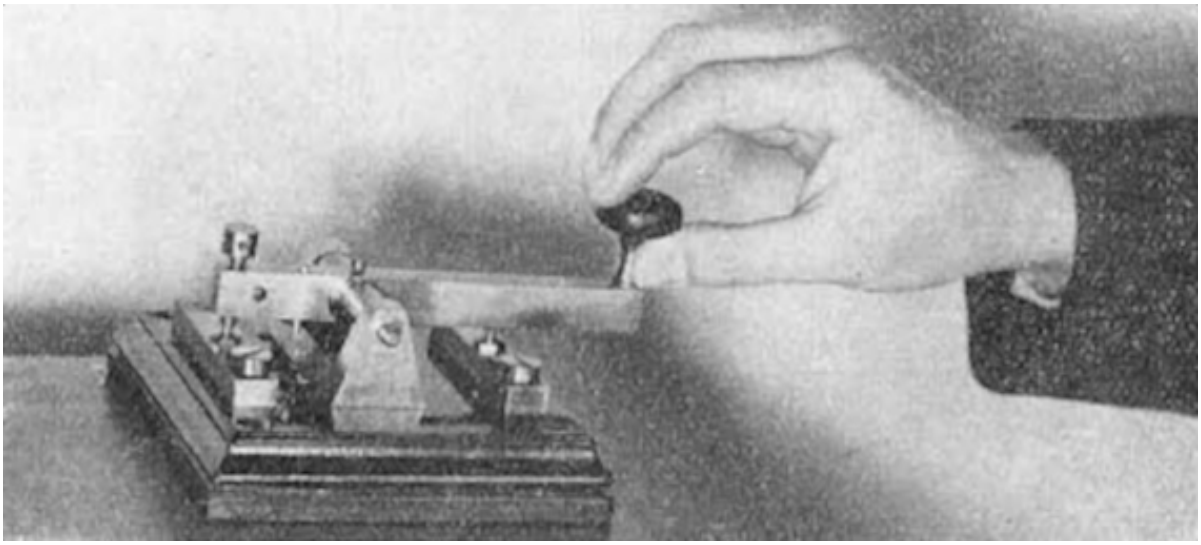
The learning series consist of group series and of mixed series. The signs to be taught and the division into groups are the same as in the buzzer training, since there was no reason to choose a different arrangement. For this, therefore, reference may be made to Tables IV and V. Both group series and mixed series are, however, constructed differently. As examples may serve Tables XII and XIII, in which series S.E. 10 (group series) and S.E. 11 (mixed series) are shown.

A division into blocks may not occur here, since no pauses longer than word pauses may occur. Each series is, from the beginning to the end, divided into groups of 5 signs, of which 2 stand on a line. After each group the word interval is punched. The whole text thus consists, in fact, of code words of 5 signs. For the correct orientation of pupil and instructor, strokes that project beyond the lines have been placed after a number of lines; these strokes, however, are not expressed in the punched material.

During the first lesson the pupil is presented with group series 1 only; further, a new group series follows in each lesson. One thus gives, in the first 11 lessons, all group series up to and including 20, and following on these, in the 3 following lessons, group series 29, 31 and 33. Series 23 and 24 follow as soon as series 20 is sent well; these are then followed by 25 and 26.

In the first lesson the pupil is also taught the correct position of the hand. Although I assume that this manual will usually be used only by experienced instructors who are familiar with sending, I nevertheless think I should give a short description of the position of the hand, because my method also lends itself to self-instruction.

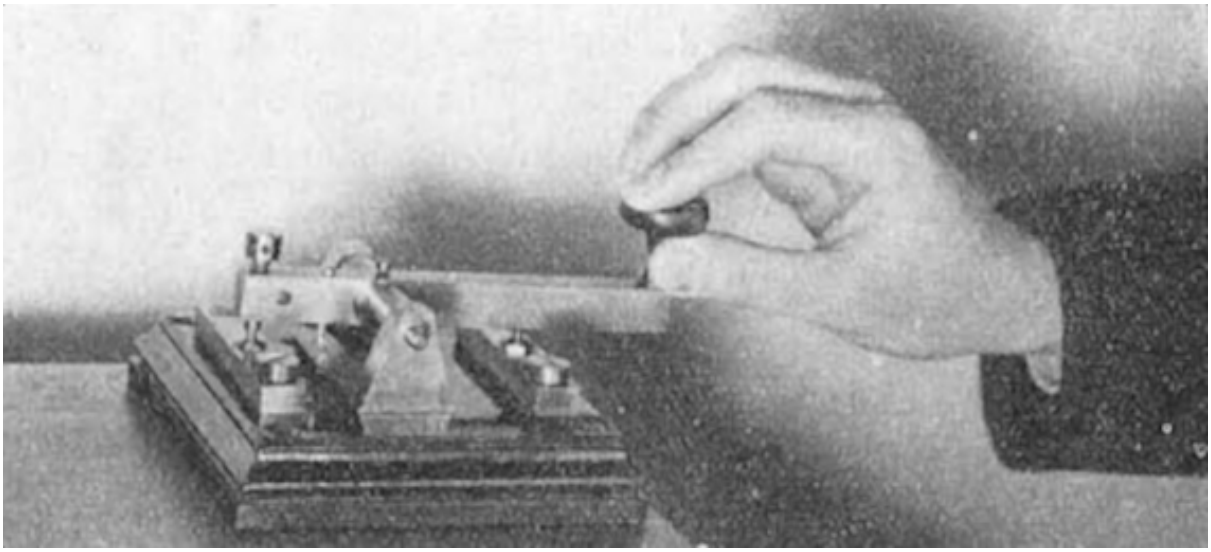
In the rest position the second to the fourth finger are laid loosely on the knob of the sending key and the thumb under the knob against the shaft of the key. Figure 5a gives a photograph of a hand in the correct position. Convulsive gripping must be avoided.



[Fig. 5a] Correct posture of the hand at rest.

The giving of a dot or a dash is done by bringing the wrist down in such a way that the hand and the knob go along with it. The forearm must remain in the same position.

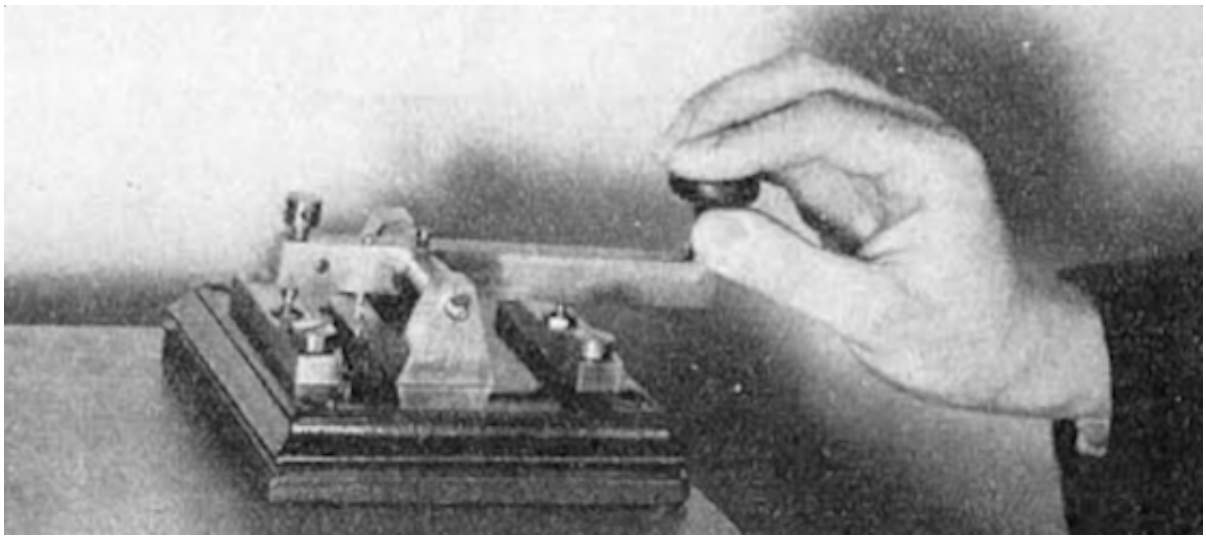
The downward movement must be as slight as possible (figure 5b); the so-called „pumping movement" in giving a dash (figure 5c) must be avoided. This can be done by the pupil making his own the idea that a dash is: a moving to a lower point, a remaining at rest on this lower point, and a moving back. The pumping movement arises because the pupil wants to remain in action during the whole time interval of a dash.



[Fig. 5b] Correct posture of the hand in giving.

As an example for learning to send, we shall take series S.E. 10 (Table XII). This series is presented for the first time in the sixth practice hour. In this hour the pupil may as yet only feel how the automatic sending key sends series 10. For this he lays his fingers loosely on the automatic sending key and lets his hand be carried along by this sending key. He makes no movements himself and

concentrates entirely on those of the automatic sending key. One lets the key send the lines with the new signs (the first 16 lines).



[Fig. 5c] Incorrect posture of the hand in giving.

In the following seventh practice hour, series 10 is again presented up to and including line 16. Now, however, the pupil is given the task of sending along with the automatic sending key, that is to say, he must try to carry out the movements of the wrist in such a way that he goes along completely with the key. As soon as the key resists his movements — which it does very forcefully, since it is moved by the attraction of a magnet — the pupil knows that he is making an error and that he had better adapt himself to the movement of the key. Forcing the movements of the automatic sending key by imposing one's own tempo on it is of course altogether wrong. If the pupil sends along entirely correctly with the key, then he no longer feels at all that it sends automatically, but gets the impression that it is he himself who sets the key in motion.

In the following eighth practice hour, series 10 is again presented, now in its entirety. Now, however, the pupil may already send on the ordinary sending key under the control of the automatic sending key. The latter is set in motion; the pupil sends the same text on the ordinary key. The taps of the automatic sending key and of the ordinary key are an aid to establishing the errors in sending: as soon as a double tap is heard, the ordinary key has struck too early or too late. The pupil's sending writing is now recorded by the Morse apparatus. Here, therefore, the hearing comes into action alongside the kinaesthetic sense.

In the following ninth practice hour, series 10 is sent freely for the first time, that is to say, the automatic sending key is put out of operation at a given moment; the pupil — in class instruction, the pupils — send on in the same rhythm. The sending writing is recorded for both parts.

The course of events for each series is thus:

feeling — sending along — sending under control — free sending

In the control booklet, which the head of the course should keep, this is indicated by:

av — ms — soc — vs.

Once a group series has been sent freely, one can proceed to the following mixed series, which is given a single time. In sending it is not as important as in receiving by ear that one has the series sent

often; what matters above all is that the pupil sends entirely correctly. For this, one series is as good as another.

Whether or not the instruction with the new method is successful depends above all on the first lessons. Of the pupil it must be required that he is prepared to accept the correction by the automatic sending key completely. Of the instructor it must be required that he points out even the smallest error and overlooks nothing. Errors that amount to only a fraction of a second are already impermissible: a wrong way of sending (e.g. with too short a word interval) during the first lessons fixes itself and can hardly be made to disappear any more. If, on the other hand, an entirely exact way of sending is fixed already in the first lessons, then it does not disappear again: it is maintained up to high speeds.

Furthermore it is of the greatest importance that the pupil knows the signs, that is to say, that he has a correct idea of what he must send. In the first lessons, or in free time outside these lessons, the pupil must therefore learn all the signs as soon as possible as combinations of dots and dashes. It is a good exercise to test the pupils on the signs by calling out a sign to them and requiring that they then write down the appropriate Morse sign. If a pupil does not react instantly, it appears that the idea of this sign is not yet sufficiently fixed in him. It is also a good exercise for the pupils to write down a piece of ordinary text, e.g. a piece from a newspaper, in Morse writing. The seeing of a letter must be followed instantly by the writing down of the corresponding image.

Psychologically the course of events may be described thus: the seeing of a written or printed letter must instantly call up an idea of a Morse sign, which may be visual, acoustic as well as kinaesthetic, whereupon, by the appropriate wrist movement, the called-up image is copied. Once Morse sending is mastered, the intermediate stages are no longer conscious, and the seeing of a written or printed letter is followed automatically by the corresponding movement of the wrist.

In the revision series 35 to 49 (example on Table XIV) all letters, punctuation marks and numerals occur, the last also as fractions. All signs occur equally often. Series 50 up to and including 60 (example on Table XV) serve for the teaching of service signs, series 61 to 70 for the teaching of abbreviated numerals. All these groups are more extensive than in the buzzer instruction, because they are used throughout the whole training, whereas in the buzzer training new series are given for these categories at every level. One begins teaching the service signs and the abbreviated numerals when the preceding signs are roughly mastered.

When the pupil has sent freely, in a proper manner, one of series 35 to 49, one of series 51 to 60 and one of series 61 to 70, then he can send at a speed of 8 wpm. As already said, one can reach this result in about 30 hours; with very gifted pupils it can be even faster, but in class instruction one must of course wait until the less gifted too produce proper sending writing. If all the instructions given in this paragraph are completely followed, then the writing of the pupils is so regular that it is hardly to be distinguished what comes from the one and what from the other pupil.

When the pupil can send 8 wpm, the tempo is raised by 1 wpm. In the first hour one first lets the pupil hear briefly what 9 wpm sounds like, then one lets him send one of series 35–39 under control, after which one again proceeds to free sending at the higher tempo. Usually, after a few practice hours, the tempo 9 wpm too is mastered; one then also has a series with service signs and a series with abbreviated numerals sent. As soon as 9 wpm is fully mastered, one proceeds to 10 wpm, then to 11 and 12 wpm. At the speed 12 wpm one presents telegrams for the first time, namely alternately plain language and code. An example of a series of telegrams in code is given in Table XVI. One first lets the pupil hear again how the automatic sending key sends telegrams, in order then to proceed as quickly as possible to sending under control and free sending. Usually the training proceeds very smoothly and no disturbances occur.

It may, however, be that a pupil suddenly relapses into an old error, e.g. wrong sending of a particular letter, or begins to send wrongly a letter that he has always sent well. In this case it is advisable to fall

back on the group series in which the letter in question occurs, and to have the pupil send along the first part of this series, first at tempo 8 wpm, then at ever faster tempo. Usually the error then disappears very quickly. If the whole writing becomes irregular, it is advisable to have learning series sent along with the automatic key again for a few hours. Up to a speed of 12 wpm, sending along is possible.

At a tempo above 16 wpm, sending under control is already very difficult. The automatic sending key can then be regarded as a pace-maker to bring the pupils up to the required tempo. This function the automatic sending key can still exercise up to high speeds (25 wpm and higher). It is then, however, necessary to make the stroke of the automatic sending key — which must be fairly large at the beginning of the training — as small as possible.

Finally it may be mentioned that one can also use the automatic sending key, outside the lessons, for the regulation of the Morse apparatus. A Morse apparatus is not a precision instrument; it is possible that it is not adjusted entirely correctly and that it makes dots and dashes either too long or too short. By establishing a connection between the automatic sending key and the Morse apparatus, one can transfer what is punched on the tape running through the Creed transmitter onto the tape of the Morse apparatus, and thereby check and regulate this apparatus. It goes without saying that during the lessons no connection between the automatic sending key and the Morse apparatus may exist.

§ 10. Aptitude for sending with the Morse key

In sending with the Morse key too, one sees gifted and ungifted pupils. Some pupils cannot learn to send, because their hands and wrists are not suitable for it and they cannot therefore carry out finely nuanced movements. This unfitness occurs, however, seldom and is usually not congenital. It is acquired through the handling of coarse tools (e.g. shovels), whereby the hands become stiff and deformed. It can further be acquired through morbid disorders (e.g. rheumatism). It is necessary, before one takes someone into training, to ascertain whether he possesses hands suitable for sending.

The most common unfitness, however, is the result of a lack of musical aptitude, of a sense of rhythm and of quick motor function. These qualities I have already named in § 5 as necessary for receiving by ear. The qualities will, however, not come into operation in the same way in receiving and in sending. In sending too there are sound-images to be perceived, but they are different and less important than in receiving. The sense of rhythm is, however, of very great importance in sending, because it must come into operation, in combination with the quick motor function, in the production of the Morse signs.

On the basis of experiences I have come to the conviction that the qualities named govern the whole work of a radiotelegraphist. I do not believe that anyone could learn to receive well and could not learn to send well if one gives him good instruction. Nor do I believe that the reverse could be the case. A psychotechnical examination need not therefore comprise separate tests for receiving and sending, but can make do with one series of tests for both activities.

CHAPTER III

RECEIVING LAMP SIGNALS

§ 11. The teaching of receiving lamp signals

With regard to the receiving of lamp signals I have carried out no experiments in the Psychotechnical Laboratory of the P.T.T. The experiences gained for this part have been obtained at the Naval Coastguard in Amsterdam.

In the instruction, use was again made of the Creed transmitter and of punched tapes. The transmitter was now connected with a lamp. For the instruction the same punched tapes were used as in the training for sending with the Morse key. The flickerings of the lamp thus corresponded to normally sent text, in which dots, dashes and pauses have the required length.

At the start of the training the tape runs through the Creed transmitter at a speed of 6 wpm. At this speed, therefore, the signs are learned. This goes quickly, since the teaching of receiving lamp signals is begun when the training for sending has been going on for some time and the signs are therefore known. In receiving lamp signals yet another sense is brought into play, the sight.

A high speed is not required in receiving lamp signals. After the signs are known visually, the tempo is raised each time by 1 wpm until 10 wpm can be taken.

§ 12. Aptitude for receiving lamp signals

In receiving lamp signals too, the pupil must have a sense of rhythm and a sufficiently quick motor function for recording in writing the sign chosen by him. Both functions need not, however, be present to such a high degree as in receiving by ear and in sending with the Morse key. It may be assumed that someone who masters these two parts properly is rhythmically and motorically sufficiently gifted to learn the receiving of lamp signals.

The fact that there are nevertheless pupils who receive well by ear and send well, but who have difficulty with the receiving of lamp signals, is to be ascribed to an entirely different cause, namely to the insufficient functioning of the organ of sight.

For the other parts too, well-functioning senses or parts of the body are needed. Someone who does not hear well cannot learn receiving by ear. Someone whose kinaesthetic sense does not function well cannot learn to send well. Someone whose hands or wrists are stiffened cannot learn to send well either. But these imperfections are indeed discovered at the medical examination. The insufficient functioning of the sense of sight, however, is not sufficiently investigated at the medical examination: this limits itself to establishing deviations of visual acuity and of the perception of colours. The deviation, however, that makes someone unfit for the receiving of lamp signals is insufficient power of adaptation, which can also be defined as sensitivity to dazzling. This sensitivity has the consequence that, after the disappearance of a flash of light, a negative after-image of the light source arises, which persists for some time and hampers the perception of the following flash of light, and at greater speeds of the successive flashes of light even makes it impossible.

The sensitivity to dazzling is also very important for other activities, e.g. that of a driver. Therefore, in the assessment of drivers in the Psychotechnical Laboratory of the P.T.T., a test for dazzling has been inserted, which has been described elsewhere.*)

This test is now also applied in this laboratory in the psychotechnical assessment of conscripts for the Naval Coastguard. It has proved possible in this way to sift out beforehand those who possess an insufficient power of adaptation and who would therefore be unable to learn the receiving of lamp signals well.

*) Biegel, R. A. et M. J. de Vries: Une installation pour la sélection des chauffeurs aux Pays-Bas (Le travail Humain 1935, Tome III, No. 2, p. 139—152).

TABLES

TABLE I RECEIVING

Speed 20 wpm

A. On the Creed tape, at a speed of 20 wpm, 506 revs (reversals) are run through in 60 seconds, thus 1 rev. = 0.12 sec.

The normal interval between the signs is 3⁄2 rev = 0.18 sec.; 1 space = 2 revs = 0.24 sec. At a speed of 20 wpm there come, per minute, 100 signs and 100 pauses. 100 pauses = 100 × 0.18 = 18 sec.; 100 signs = 42 sec.; 1 sign on average 0.42 sec.

B. Pause between the signs per interval:

Interval	*Pause (sec.)*	*In reversals*
1	0.18	3⁄2 revs
1½	0.30	3⁄2 + 1 rev
2	0.42	3⁄2 + 2 revs
3	0.66	3⁄2 + 4 revs
4	0.90	3⁄2 + 6 revs

C. Number of signs per minute (sign length 0.42 sec.):

Interval	*Sign (sec.)*	*Pause (sec.)*	*No. of signs/min.*
4	0.42	0.90	45 = 9.0 wpm
3	0.42	0.66	55 = 11.0 wpm
2	0.42	0.42	71 = 14.2 wpm
1½	0.42	0.30	83 = 16.6 wpm
1	0.42	0.18	100 = 20.0 wpm

TABLE II.

Final speed 25 wpm

Interval	*Length of sign*	*Length of pause*	*No. of signs/min.*
6	0.34	1.09	42 = 8.4 wpm
5	0.34	0.90	48 = 9.6 wpm
4	0.34	0.71	57 = 11.4 wpm
3	0.34	0.52	70 = 14.0 wpm
2	0.34	0.33	90 = 18.0 wpm
1½	0.34	0.24	103 = 20.6 wpm
1 (normal)	0.34	0.14	125 = 25.0 wpm

Final speed 20 wpm

Interval	*Length of sign*	*Length of pause*	*No. of signs/min.*
4	0.42	0.90	45 = 9.0 wpm
3	0.42	0.66	55 = 11.0 wpm
2	0.42	0.42	71 = 14.2 wpm
1½	0.42	0.30	83 = 16.6 wpm
1 (normal)	0.42	0.18	100 = 20.0 wpm

Final speed 16 wpm

Interval	*Length of sign*	*Length of pause*	*No. of signs/min.*
4	0.53	1.11	36 = 7.2 wpm
3	0.53	0.81	45 = 9.0 wpm
2	0.53	0.52	57 = 11.4 wpm
1½	0.53	0.37	67 = 13.4 wpm
1 (normal)	0.53	0.22	80 = 16.0 wpm

Final speed 12 wpm

Interval	*Length of sign*	*Length of pause*	*No. of signs/min.*
3	0.70	1.09	33 = 6.6 wpm
2	0.70	0.69	43 = 8.6 wpm
1½	0.70	0.49	50 = 10.0 wpm
1 (normal)	0.70	0.30	60 = 12.0 wpm

TABLE III.

Schema of Z.E. series (receiving)

Interval	*Series*	*Content*
Int. 4	Z.E. 1 — Z.E. 34	signs in groups
	Z.E. 35 — Z.E. 49	signs mixed
	Z.E. 50	service signs only
	Z.E. 51 — Z.E. 60	mixed w. service signs
	Z.E. 61	abbreviated numerals only
	Z.E. 62 — Z.E. 65	abbr. numerals with fractions
Int. 3 (series = 200 ch.; text = 600 ch.)	Z.E. 66 — Z.E. 105	practice series, each time 2 series and 2 texts
	Z.E. 106 — Z.E. 115	mixed w. service signs
	Z.E. 116 — Z.E. 120	abbr. numerals with fractions
Int. 2 (text = 800 ch.; tgm = 800 ch.)	Z.E. 121 — Z.E. 180	practice series, each time 2 texts and 2 tgms
	Z.E. 181 — Z.E. 190	mixed w. service signs
	Z.E. 191 — Z.E. 195	abbr. numerals with fractions
Int. 1½ (tgm = 800 ch.)	Z.E. 196 — Z.E. 235	practice series, tgms
	Z.E. 236 — Z.E. 245	mixed w. service signs
	Z.E. 246 — Z.E. 250	abbr. numerals with fractions
Int. 1 (tgm = 800 ch.)	Z.E. 251 — Z.E. 300	practice series, tgms (code)
	Z.E. 301 — Z.E. 370	practice series, tgms (plain language)
	Z.E. 371 — Z.E. 390	mixed w. service signs
	Z.E. 391 — Z.E. 410	abbr. numerals with fractions

TABLE IV. MORSE SIGNS

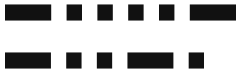
LETTERS

a		i		r	
b		j		s	
c		k		t	
d		l		u	
e		m		v	
é		n		w	
f		o		x	
g		p		ij	
h		q		z	

NUMERALS

1		6	
2		7	
3		8	
4		9	
5		0	

PUNCTUATION MARKS

.	dot	
,	comma	
:	colon	
?	question mark	
'	apostrophe	
-	hyphen / dash	
/	fraction bar	
()	brackets	
_	underlining	
=	double dash (sep.) / mixed number and fraction or mixed number and letter	 

SERVICE SIGNS

understood sign (with radiotgf. calling sign)

error sign

cross or closing sign (+)

K sign (invitation to transmit)

waiting sign

acknowledgement sign (end of the correspondence)

calling sign (beginning of each transmission)

ABBREVIATED NUMERALS

1

2

3

4

5

6

7

8

9

0

TABLE V. DIVISION INTO GROUPS

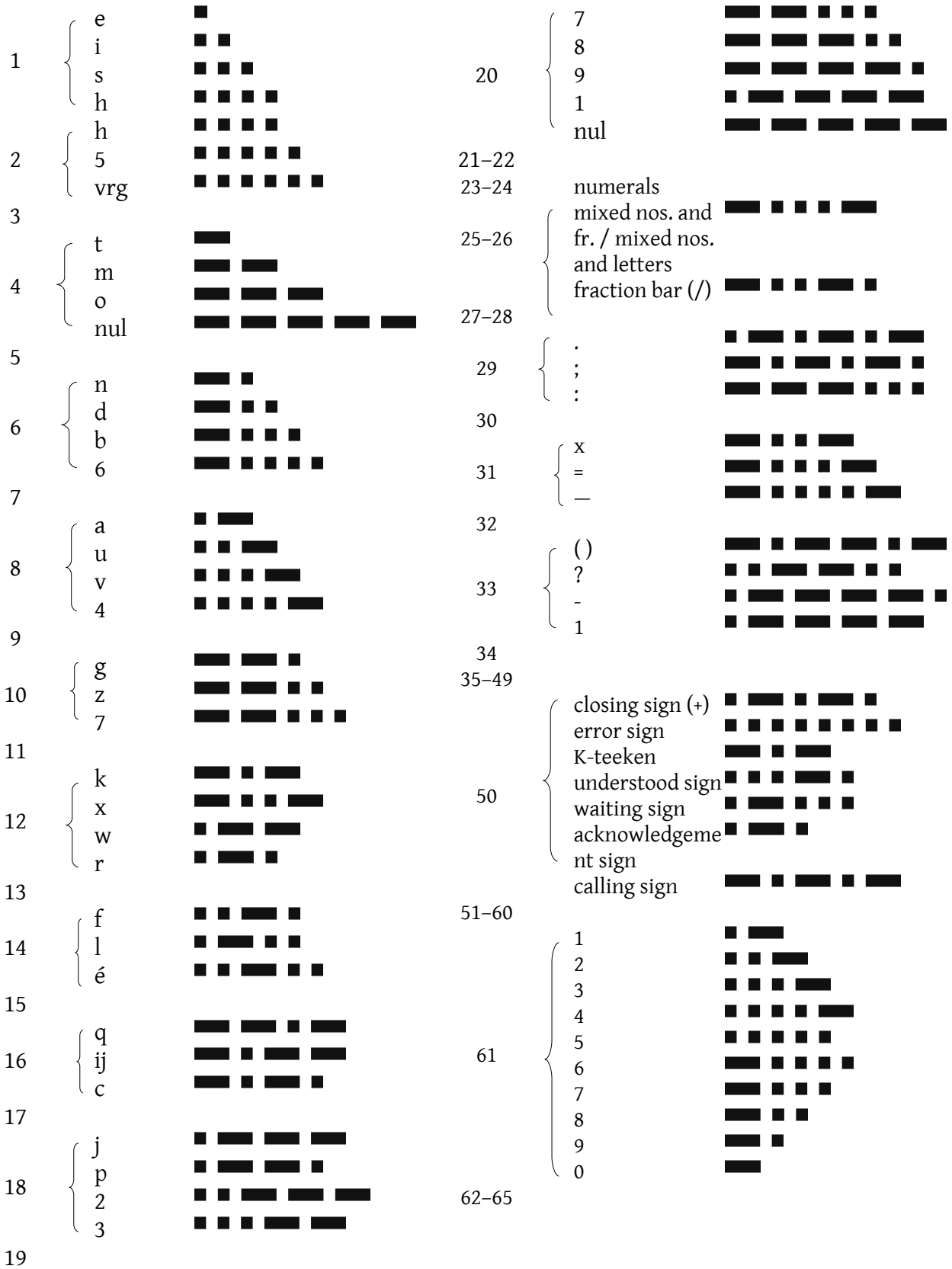


TABLE VI. RECEIVING

Example of a group series
Series Z.E. 8

a	a	a	a	a	a	a	a	a	a
u	u	u	u	u	u	u	u	u	u
v	v	v	v	v	v	v	v	v	v
4	4	4	4	4	4	4	4	4	4
4	u	v	a	v	u	a	v	4	a
u	a	4	v	a	v	u	v	4	u
a	4	v	a	4	v	u	4	a	u
v	4	a	v	u	4	u	v	4	a
4	u	v	4	a	u	v	a	4	u
u	v	a	4	u	a	v	u	4	a
t	4	m	a	n	v	6	u	e	v
h	u	4	v	a	s	e	nul	u	m
v	i	u	d	s	a	o	4	i	a
a	h	5	4	e	u	vrg	v	b	4
v	b	t	a	d	5	nul	u	5	vrg
m	s	vrg	i	o	u	n	h	6	4
a	nul	a	d	e	t	o	4	b	h
vrg	s	n	m	u	5	i	6	t	v

Example of a mixed series
Series Z.E. 9.

m	e	s	4	n	t	a	i	b	vrg
nul	i	5	4	d	e	u	o	v	h
vrg	s	n	6	s	b	u	i	a	m
v	nul	e	h	t	6	h	d	o	5
h	vrg	d	i	4	n	5	5	t	b
o	m	5	t	nul	s	v	vrg	a	e
s	a	t	v	6	h	4	d	m	u
b	e	u	n	vrg	m	o	6	i	nul
6	5	nul	i	d	n	t	4	h	o
4	s	a	o	v	e	u	m	n	vrg
n	t	v	s	nul	d	5	b	i	nul
e	a	d	vrg	b	h	6	o	u	m
t	h	b	n	s	6	vrg	b	e	v
4	d	i	a	m	6	5	u	o	t
s	v	nul	vrg	6	a	o	b	4	i
e	a	n	5	u	d	h	u	m	nul

TABLE VII. RECEIVING

Example of a revision series
Series Z.E. 39.

h	—	t	b	=	1	:	w	d	ij
1	3	5	2	4	6	n	p	o	
s	i	j	f	.	m	a	x	:	j
q	’	c	k	o	é	g	u	,	e
2	0	5	6	89/67					
v	h	?	f	z	p	b	=	k	w
(	l	n	i	ij	l	’	c	s	)
m	—	d	x	r	a	u	vrg	k	o
,	e	é	q	j	t	g	p	.	h
l	ij	b	:	w	m	?	i	z	n
	f	v	q	s	o	’	p		—
4	1	0	3	67/57					
l	.	a	vrg	n	d	n	c	r	j
f	x	i	t	h	w	o	z	e	—
v	q	a	8	6	7	9	4	2	
,	k	c	p	.	m	ij	a	=	g
l	vrg	h	é	r	b	’	j	u	n
f	?	q	d	z	o	p	i	q	m
:	j	x	e	w	g	=	s	b	—
	r	n	t		ij	c	v	,	p

TABLE VIII. RECEIVING

Example of a series with service signs
Series Z.E. 51.

c	q	understood sign			xxxx	a	h		o
e	closing sign			xxxx	g	b	d		p
waiting sign			xxxx	t	f	l	i		j
r	n	u	K-teeken			xxxx	k		ij
acknowledgement sign			xxxx		calling sign				xxxx
error sign			xxxx		closing sign				xxxx
—	d	s	a	m	h	t	’	l	u
é	k	,	f	o	w	b	e	?	x
understood sign			xxxx		acknowledgement sign				xxxx
z	(	j	u	p	r	)	g	q	.
=	a	w	error sign		xxxx	’	:		
K-teeken			xxxx		calling sign				xxxx
ij	x	i	d	o	waiting sign				xxxx
closing sign			xxxx		l	a	n	c	é
,	’	acknowledgement sign			xxxx	(	f	k	)
?	b	q	K-teeken			xxxx	h		—
z	g	e	p	understood sign			xxxx		b
.	waiting sign				xxxx	s	r	j	t
error sign				xxxx	w	m	c	v	d
é	a	n	u	l	x		i		ij
?	c	(	h	)	acknowledgement sign				xxxx
:	f	o	closing sign				xxxx	z	.
e	s	k	t	.	p			—	p
calling sign				xxxx	g	b	h	q	=
i	m	v	d	w	g		e		:
understood sign				xxxx	x	j	n	?	é
closing sign			xxxx			error sign			xxxx
=	(	k	j	)		waiting sign			xxxx
r	K-teeken			xxxx		v	’	c	l
,	:	i	—	z	calling sign				xxxx
ij	m	.	p	o	closing sign				xxxx
q	v	s				n	m	’	=

TABLE IX. RECEIVING

Example of a text
Series Z.E. 134.

och snorva . dessa stationer voro avsedda for 1 q 2 zakoa zel dne 14 . cervna 1926 , 103 sbozoantbelleza de edificios, regu|laridad de calles, condiciones og 5846 var ansatt i distrikténe (postapnereg) extension des télégra de fin de semeine|, dits : kovetkeztetés érdekében azert kell ismernunk : hogy involves the distribution of about : 2.200.000 pounds sta|abi poolt (tallinn — naissaare) va20 juhtmed bestand entnommen : ausschlaggebend fur die auswahl de ropomt (wochent|lich) und von bezirks — wirtschafts tj — bem? His afsenderen ikke har foreskrevet kontrolord paa hojst 10 bogstaver for|rest i teksten ved stortingsbeslutning av 5 juni 1930 tradte nyt 's statens jarnvagar? vid flygstationerna i stockho|lm utgjorde vid arets slut 4 7/9 rundradiostationer

avinurmega sai rakvere poolt kon248 labi tudu gusano del hamb|re, con el proposito de hacerlo a wortschaftspolitik : die deutsche reichspost ist vom aven, som et uttryck for 479.865|

TABLE X. RECEIVING

Example of a series with telegrams
Series Z.E. 167.

soerabaja - asd : 80253 20 10/6 17.3 = consumenten soerabaja = xifhyicifz éagdakyomv bdeflagrus vehqaeihoo judarguic|t évebxiljce abxaiibdvu vafsaiqayp dmeaoglybr uxugzewtub ahgoyizjyo axrymihimm éomagasevs ezvaiempce afsojdaez|a ahielisjyh gaowkkaemh duyhjgetna + mwz - vught 77 26 16/6 9 16 = van houweling villa mees? Noordwijkazee = mand groenten |verongelukt? spoor : koop, zes personen doperwten groote boonen , kapzijnders 18, kropsla , aardbeien : voor piet : 12 st|engels rabarber , (love?) = annie . + paris — amsterdam : 60905 14 10/6 14.38 = press (kanas) paris = santos juin 21 7/8, se|ptembre 22 1/8. décembre 22 1/8, mars 22 1/8 mai 22 + bln — asd : nr 337 15/14 7/6 21.46 = presse uniontel berlin = zusamme|nhang erbeben england sonntagnacht verschiedenen teilen holland leichter erdstosz wahrgenommen ? = (rasser) + tela|viv — 's — gravenhage 50506 16 8/6 12 = lcd = dutchbank telaviv = deliver documents draft pounds 20 ? hav281 without pay|

TABLE XI. SENDING

Schema of S.E. series

		Learning series	
S.E.	1	through 34	signs in groups
		Practice series	
S.E.	35	through 49	mixed
S.E.	50		service signs
S.E.	51	through 60	mixed with service signs
S.E.	61		abbreviated numerals only
S.E.	62	through 70	abbr. numerals with fractions
		Telegrams	
S.E.	71	through 75	plain language
S.E.	76	through 80	code
S.E.	81	through 85	plain language
S.E.	86	through 90	code
S.E.	91	through 95	plain language
S.E.	96	through 100	code

TABLE XII. SENDING

Example of a group series

Series S.E. 10

g	g	g	g	g	g	g	g	g	g
z	z	z	z	z	z	z	z	z	z
7	7	7	7	7	7	7	7	7	7
7	g	z	g	7	z	g	g	7	z
z	g	7	z	z	g	7	z	g	7
7	z	g	7	g	z	g	7	z	7
g	7	z	g	z	7	z	7	z	g
z	g	z	7	g	7	z	g	7	g
7	g	z	7	z	7	g	z	g	7
7	g	z	z	7	g	z	g	7	z
z	g	g	z	g	z	7	g	z	7
z	7	7	z	7	g	7	g	z	g
g	7	z	g	7	z	g	7	g	z
z	g	7	z	7	g	7	z	7	g
g	g	z	7	z	7	g	7	g	z
z	7	g	7	g	7	z	g	7	z
g	n	7	i	6	z	nul	7	z	m
s	z	v	vrg	7	m	z	b	v	g
h	g	d	z	a	e	g	u	z	7
t	7	o	g	b	4	z	n	g	5
7	z	o	7	g	v	h	g	nul	z
z	6	g	m	7	z	u	7	i	g
7	g	e	7	4	g	4	z	vrg	7
z	o	5	g	d	t	7	a	g	s
s	7	4	e	o	z	i	e	nul	5
z	vrg	h	6	t	z	n	i	m	g
i	b	g	a	d	7	u	s	v	t
m	5	n	4	z	nul	i	g	a	7
e	6	g	u	vrg	z	o	v	h	b
s	d	7	4	s	5	g	m	n	g
vrg	i	t	7	d	u	5	b	z	t
z	6	h	nul	g	a	e	o	v	7

TABLE XIII. SENDING

Example of a mixed series

Series S.E. 11

e	n	5	b	t	u	t	7	e	m
g	o	m	g	s	6	h	z	nul	i
v	5	i	n	4	m	o	h	s	d
u	nul	m	i	vrg	b	t	s	g	a
s	7	h	z	e	u	i	o	4	5
i	h	d	v	6	vrg	a	n	i	s
nul	e	i	z	o	b	h	a	vrg	7
m	6	5	4	s	u	t	v	e	d
e	4	z	vrg	g	t	a	nul	s	o
5	n	m	6	h	e	nul	i	6	u
h	o	v	b	5	z	d	t	o	5
u	s	7	a	nul	h	6	v	b	7
o	d	t	4	m	vrg	vrg	e	z	i
n	m	g	5	s	v	e	i	7	d
g	t	h	b	vrg	m	nul	a	o	4
5	u	e	6	t	v	h	vrg	i	n
5	v	m	a	e	6	7	t	o	m
4	h	n	nul	g	vrg	v	s	b	u
a	u	z	i	4	d	m	a	7	e
5	7	vrg	m	o	n	t	nul	6	h
n	6	e	v	vrg	5	b	s	g	u
t	nul	b	o	i	o	d	5	a	n
5	4	t	z	b	m	d	v	h	4
d	n	s	u	vrg	6	g	i	z	m
o	d	e	6	nul	b	t	nul	v	h
s	t	4	m	g	5	a	7	vrg	7
g	n	z	i	u	t	7	s	nul	g
a	vrg	v	s	6	o	4	e	n	d
e	d	o	n	6	a	h	z	m	vrg
b	a	nul	v	5	g	n	i	u	z
g	6	h	z	d	4	r	7	nul	e
b	u	t	b	m	a	i	4	5	t

TABLE XIV. SENDING

Example of a revision series

Series S.E. 35

i	vrg	s	w	q
2	5	9	4	8
.	c	m	:	ij
?	b	=	p	—
j	vrg	f	g	x
o	,	d	:	w
m	t	é	a	r
v	8	7	4	
q	h	:	b	vrg
(	x	s	k	p
z	vrg	d	h	m
p	?	u	a	t
b	i	—	’	s
i	:	f	=	j
q	t	t	z	b
u	—	vrg	c	é
g	q	x	m	p
s	,	b	=	1
n	i	.	k	d
8	½			
r	=	a	t	v
c	w	p	g	r
m	vrg	(	ij	1
é	d	s	?	e
t	é	n	v	j
f	:	m	x	a
q	s	j	=	d
vrg	b	m	i	ij
3	8	5	2	7
m	g	’	z	1
r		n	p	
?	,	c	s	.
f	vrg	n	:	b
t	a	d	r	1
b	o	w	i	h
,	k	o	?	a
9	4	3	a	
’	a	x	q	=
d	o	t	g	.
.	e	ij	m	—

h	z	,	k	o
3	7	2	6	1
a	é	l	t	f
u	e	’	n	v
	q	?	c	
h	r	z	f	s
n	c	u	i	ij
3/678				
i	’	o	,	g
=	e	t	j	)
ij	—	l	é	r
g	r	w	c	v
k	e	4	5	
.	h	j	o	?
x	ij	d	,	r
e	v	n	’	w
?	a	w	f	:
ij	h	o	j	u
	u	k	é	
4	9	7	6	3
f	v	q	z	s
x	e	’	h	,
:	n	)	k	u
1	=	i	.	1
o	z	b	p	—
,	h	w	g	r
u	1	’	c	p
e	v	f	?	k
81/30				
n	x	a	é	o
w	d	q	h	u
i	ij	e	—	m
=	j	z	c	k
q	x	g	’	p
	é	r	v	
u	p	f	z	j
8	6/5			
(	z	1	v	)
k	é	b	vrg	j
g	s	:	c	n

TABLE XV. SENDING

Example of a revision series

Series S.E. 35

K-teeken			error sgn				h	u	s	f	(		k	u		)
r	a		calling sign					n	l	u	i		b	m		.
error sign				d		,	r	?	1	closing sign			n	ij	a
u	(			q		?		)	acknowledgement sign			o	v	t	é
waiting sign				e		p	:	g	3			5	9	0	2
e	c			k	ij			h	c	n	K-teeken			v	z
understood sign				b	é	t		u	x		:	o	j		:
acknowledgement sign				—	.	a		p	calling sign			?	=	’	a
c	?	u			—			a	n	:	(		a		)
error sign				a	n	q		u	t	closing sign			,	w	p
	o	m						a	q	s	w	x		calling sign	
a	j	d				1		s	K-teeken			r	u	ij	’
acknowledgement sign				m	k	z		k	m		z	z	a		t
k	z	i		waiting sign				.	v		é	r	:		e
K-teeken				a	1	é		f	a		?	p	s		ij
u		h		t		b		a	i	error sign			x	=	d
2		1		4	b				7	½					
b	q			d	1			o	b	h	understood sign			c	c
.	j	understood sign			,			n	u	u		?		n	w
b	x	v			c			r	g	acknowledgement sign			?	=	a
s		a			:			ij	f		(	p	?		)
calling sign				n	:	i		a	(		x	)	b		b
error sign				d	o	—		é	c		o	r			
closing sign				q	j	s		o	K-teeken		,	—	.	’	
e		d			a	j		w	=	waiting sign			ij	r	t
g		.			1	é		:	f		w	u	h		z
understood sign				,	n	v		=	5		3	8	6		7
waiting sign				e	r	ij		p	f		o	?	i		e
4/6	1								u	—	closing sign			e	?
calling sign				h	u	w		d	6		8	3	a		
j				o				n	calling sign			1	k	u	z
1		m			=	f		n	n	understood sign			s	.	j
q	o	K-teeken				t		c	i		?	k	a		m
h		d			:	v		’	o		w	,	n		p
u		w			s	v		t	acknowledgement sign			f	é	.	:
waiting sign				a	g	i		v	8		9	3	5		4

understood sign			o	,	?	b			error sign			n	z	:	f				
n	o	p	closing sign			o			q		.	g	é		a				
q	x	g	,	m					closing sign			(	h	x	)				
4	6	9	7	8					5	2	8	6		7					

TABLE XVI. SENDING

Example of a series of telegrams (code)
Series S.E. 88 Code

mozambique amsterdam 179 15 2/12 10.21 = dlt = (tetzner)

mozambique = ueberweiset telegrafisch weitere escuden 500 f|alls moeglich 7200 westminsterbank dratet rimittierte gesammtsumme? = handelmij + gd s-hertogenbosch 2052 39 2/12 14| : 00 = landman = acoakyqsui isdysjinmo ymlswponob aéautynck xomtzoiosh mamovjiomp lyaixhojki; palatséril adede|véstn adajoyeayj urulbympri isasiyopub isatgynkxo isatgynkxo yqénisyhla gsuskuqzge = henkel + coventry ’s-Graven|hage 186 19 1/12 15.43 = joustra

coventry = ship immediately 12 oversize pistons complete with rings 9047 cable clea|rance to fit piston and rings = eduard + boston leiden 2076 7 2/12 16 : 14 = (monety)

boston = roguvlilka 840we ab7 jiejs|lilka riydabuyan ux-glaupapt = heyboers + bucarest ’s-Gravenhage 42 13 1/12 09.55 = verglassen neuerburger precupetij|ivechi 1 bucarest = sinceres félicitations et meilleur voeux de bonheur? = rudesheim + mt utrecht 81 6 7/12 1.18 = hans =|

Colophon

The automatic sending key described in this booklet, and likewise all normal sending keys, were supplied by: Fa. Ridderhof & Van Dijk, Radio Apparatus & Instrument Factory, De la Reylaan 37/39, Zeist (Telephone 3455, after 6 o'clock 2188).

Source: R. A. Biegel, „Nieuwe methoden voor opleiding van radiotelegrafisten en telegrafisten", Waltman Publishers, Delft, 1939 (Psychotechnical Laboratory of the P.T.T.). Transcription preserving the original spelling.