

G. Dändliker



The public telephone service is now so much taken for granted that it is difficult to think of a world without it. As the network expanded so did the demands placed upon the service. Today, the problems are no longer the connections or the clarity but the method of invoicing and the way the customer pays. Unfortunately, the pay-telephone must in addition be protected against misuse, fraud and vandalism. The following article deals with a solution of these problems by means of a telephone credit card system PHONOCARD®.

1. Introduction

There is no doubt that the telephone has become the most frequently used, the most versatile and the most popular means of communication. We have all become used to finding a telephone available anywhere and at any time to enable us to telephone at work or during our leisure hours. Besides business and

private telephones, we depend on public telephones to cover our communication needs, especially the coin-operated telephones in post offices, stations and roadside kiosks. The user has become so used to coin-operated telephones, available for use at all times, that he can no longer do without them. A few figures on their distribution in different countries illustrate their growth.

2. Present situation of coin telephone

In selecting a new coin-operated telephone, telephone administrations attach particular importance to the two following aspects. First, the coin telephone is considered as an item of capital goods, to be used as profitably as possible and, second, the social function of the public telephone has also to be furthered, which is of particular importance in the case of free emergency calls. While coin telephones at locations where there are large numbers of people can be extremely profitable, it is also necessary to install coin telephones in remote, relatively un-frequented places, in order to provide geographically disadvantaged citizens with the same service, even if in this case



Fig. 1 PTT administrations and telephone companies give attention to other things besides economics in the use of the telephone. Remote kiosks, free emergency calls, etc. are among the services which are not profitable and which give rise to certain problems.

	Telephones (of all kinds)		Public telephones		
	Total number ($\times 10^3$)	Density per 100 people	Total number	Density per 1000 telephones (all kinds)	Density per 1000 people
U.S.A.	168.994	77,0	1.840.000	10,9	8,4
Sweden	6.160	74,4	38.686	6,3	4,7
Switzerland	4.292	68,2	*32.287	7,5	5,1
Denmark	2.935	56,5	26.334	9,0	5,1
Japan	52.937	45,8	849.901	16,0	7,4
Holland	6.340	45,4	8.977	1,4	0,6
Finland	2.127	44,7			
United Kingdom	24.935	44,6	275.000	11,0	4,9
FRG	24.743	40,3	151.310	6,1	2,5
Norway	1.636	40,2	9.909	6,1	2,4
France	19.870	37,3	171.748	8,6	3,2
Austria	2.618	34,0	20.163	7,7	2,6
Belgium	3.271	33,2	**6.522	2,0	0,66
Italy	17.081	30,1	261.184	15,3	4,6
Spain	10.311	28,0	56.556	5,5	1,5
Greece	2.487	26,5	14.697	5,9	1,6
Portugal	1.254	12,7	2.535	2,0	0,3

Source: The World's Telephones, a statistical compilation, as of January 1979

** Source: Belgian PTT, December 1980
* Source: Swiss PTT, December 1980

Fig. 2 The table shows the distribution of telephones and public telephones in different countries.

the operation of the telephone is questionable as regards profitability. Since the uneconomic operation of such telephones has to be financed from public funds or, in the case of private telephone companies, gives rise to losses, in the choice of a public coin telephone, particular attention is given to high reliability and economic operation. However, financial considerations alone are not decisive since the user expects a modern telephone to provide modern convenience in operation.

On considering the development of the telephone from its introduction to the present state of the art, the most striking thing is the multiplicity of systems used. This may be ascribed to the independent development of the national telephone systems and the differing practices in the various countries. Since telephones were designed from different points of view and in most cases did not manage to combine factors such as high reliability and optimum convenience in the same telephone, the development of a standardized system has hitherto been practically impossible. However, the basic conditions established by the different telephone administrations are similar.

These are as follows:

- Telephones suitable for the existing telephone network and charging system
- Construction resistant to being broken open
- Simple operation of the telephone
- High availability of the telephone
- Operation with available coins
- Pleasing design

These are associated with certain basic functions such as:

- Checking that the inserted coins are genuine

- Calculating the costs of the calls
- Collection and possible return of coins
- Control of the connection
- Safe keeping of the collected coins.

Several possible difficulties are associated with these typical functions of the coin-operated telephone:

3. Difficulties associated with coin telephone

3.1 Fraud by use of counterfeit coins

This can involve counterfeit coins, foreign coins or foreign objects similar to coins.

3.2 Availability of the required coins

In certain countries, there are not enough coins in circulation or their value is too low for most telephone calls.

Today it is possible to equip telephones with bank note testing units. These have already proved their value in vending machines for petrol or tickets. However, in this case, an increased risk of being broken open can be expected and returning change gives rise to new problems.

3.3 Limited number of usable coins

Because of the costs involved, in general it is not possible to use any desired number of coin testing units, and therefore coin values, in a coin telephone. Thus, for example, in the Federal Republic of Germany, of the range of coins available, only the ten pfennig,

one mark and five mark coins are used for telephoning. The 50 pfennig and two mark pieces cannot be used.

3.4 Minting of new coins

For various reasons, coins are replaced from time to time by new versions. In most cases, the recommendations of the manufacturers of coin-operated machines are not taken into consideration. This later gives rise to considerable technical effort and costs.

3.5 Calculation of call costs

In general, metering pulses, transmitted from the telephone exchange where they are generated, are used for the calculation of the call costs. The actual calculation of the call costs takes place at the exchange or in the coin telephone. Tariff changes can give rise to difficulties.

In the event of tariff changes, it is often necessary to modify all the coin telephones, which is usually associated with a high expenditure of effort and costs.

3.6 Breaking open and theft

Although in most cases coin telephones contain no great amount of money and the persons breaking them open do not know how much there is inside, nevertheless many cases of breaking open or attempting to break open occur. Experience has shown that in safeguarding the collected money increased security measures and expenditure lead to the use of more powerful means by the thieves, for example heavier tools. In this



Fig. 3 The different practices and the independent development of the national communications systems have led to a great variety of types. Although the different telephone administrations set similar requirements for the telephone, it has not previously proved possible to make a standard telephone which in addition offers high security and optimum convenience.



Fig. 4 This broken coin telephone is a typical example of the often disproportionate means which are employed to get possession of the cash box.

case, the damage caused to the telephone and the kiosk is always greater and generally represents an amount much larger than the sum stolen.

3.7 Coin collection and handling

Collection of the coins stored in the telephones gives rise to considerable costs for the telephone administration. Costs include the security measures to prevent embezzlement by the personnel entrusted with the collection of the coins and also the expenditure arising from the sorting, counting and packaging of the coins.

3.8 Return of coins

In order to keep the manufacturing and operating costs of coin telephones as low as possible, hitherto, even when high value coins are used, returning any money has been dispensed with, or only inserted but unused coins have been returned.

4. Available possibilities for public telephone traffic without coins

4.1 Attended telephones

In the case of attended call-boxes in post offices, a telephone in a booth is made available to the user. A monitoring installation determines the charges for the

call made and delivers a voucher. The user pays the required amount at the counter.

The operation of such installations, which offer maximum convenience for the user, is only advisable in places where large numbers of calls are made, thus ensuring the profitability of the installation. However, uninterrupted 24-hour operation of such an attended installation is hardly imaginable, even if operation should be entrusted to private enterprise.

4.2 Telephoning on credit

Telephoning using a credit system is quite common in the USA. Here, the user must tell the exchange of the telephone company the account number of his credit card or his own telephone number before making the call. All the call costs incurred by the caller are charged to his account. He receives the telephone account at the end of the month. The main advantage of this procedure lies in the great convenience for the user, who needs no cash to make a telephone call. In addition, coin collection is avoided and calculation of the charges is simplified for the telephone company.

The most important disadvantages which should be mentioned are the attempts at fraud, which are not excluded with this procedure. These can give rise to considerable losses for the telephone company, despite expensive protective measures such as the use of black lists.

The considerable costs given rise to by the manual intervention of the exchange can be reduced to a very large extent by the use of modern computerized techniques.

5. Requirements for a new system

The problems which have arisen in the past in the operation of coin telephones, taken together with practical experience and trials, enable a set of requirements to be drawn up for a new improved system.

1. Simple procedure for settlement of the charges for both inexpensive and expensive calls, demanding the least possible attention on the part of the user, i.e. distinguished by increased convenience.
2. Higher security against forgeries and fraudulent manipulation.
3. Operation without cash; if there is no cash-box and no cash, this is no longer a motive for breaking open the equipment.
4. Reduced effort for collection of the charges.
5. Simple and precise accounting.

6. New solution: Prepaid value-card replaces cash

Considering these prerequisites for a new telephone, it is clear that a system operating without cash is most likely to meet these requirements.

The special feature of the new system lies in the nature of the means of payment, the optically coded value-card described below. This has the format of a conventional credit card and contains a certain number of units of value. The card is purchased before telephoning, is inserted in the telephone and during the call, while it is inside the telephone, is steadily reduced in value. The value units on the card replace coins and the user no longer needs to bother about inserting coins during the call.

6.1 Advantages for the telephone administration

Since the costs for coin collection and processing are eliminated, operating costs can be considerably reduced.

Since telephones operated by prepaid cards no longer contain money, breaking open is abandoned. It will be shown below that this system also offers particularly high security against forgeries so that one of the most important requirements for a new system is satisfied.

It has been established that with the use of the prepaid card telephone more telephoning is done, this being largely due to the increased convenience for the user.



Fig. 5 The operation of attended telephones meets the requirements of increased security and user convenience to a large extent. The telephones are connected to a call data recording installation and the user obtains a printed receipt on payment of the call. However, this installation is only economic when many calls are made and continuous operation is hardly possible because of the high manpower requirements.

The purchase of the card in advance represents an additional source of finance for the telephone administration because when the cards are sold substantial amounts of money are received while the associated service in return, the telephone calls, is only claimed later.

6.2 Advantages for the user

Coins are no longer necessary in order to telephone and the user can even make long international calls, «a la carte», without risking being cut off in mid call because of a lack of coins. Exact settlement, i.e. reduction in value of the card, is ensured for both lengthy and brief telephone calls.

7. The PHONOCARD operated telephone

The PHONOCARD is a telephone for operation by means of prepaid value-cards. Besides the usual components of a conventional telephone, such as the handset and the keypad, there is a digital display to indicate the number of valid value units on the card and also a card insertion slot. The PHONOCARD comprises two basic units: the card reader, with its associated electronics, and the electronic circuitry associated with the telephone system, which is connected to the card reader, the telephone line, the handset and the dialling mechanism.

To make a telephone call, the handset is lifted, a valid card is inserted in the slot and the required number is dialled. The credit balance display constantly keeps the user informed as to the number of value units remaining on the card. In addition, optical and acoustical signals warn the user some 20 seconds before the credit will run out, when the call would be cut off. If the user has another valid card, he can continue the call without interruption. After the warning, pushing a button causes the credit balance remaining on the card to be stored electronically in the equipment and the now valueless card is returned. The customer can now insert another card.

It is possible to terminate one call and then start another one, without removing and reinserting the card, by momentarily depressing the hook switch.

The user can check the credit balance remaining on the card, without telephoning, by inserting the card in a PHONOCARD telephone with the handset still on the rest. The credit balance is displayed for a few seconds and the card restored to the user.

The equipment is controlled by a micro-processor which is capable of looking after additional functions, for example blocking certain predetermined numbers, the dialling of certain numbers without payment for emergency calls and the handling of statistics.

7.1 Value-card

The card is the same size as a conventional credit card. The number of value units, which in principal can be chosen as required, is arranged to offer the user maximum convenience and exact settlement. The card can be overprinted with the indications of the telephone administration and, if necessary, with certain information for the user. The individual unit values are in the form of an optical microstructure, invisible to the naked eye, arranged in one or two tracks on the card. At the beginning of each track there is a synchronization bit for synchronizing the reader and seven identification bits carrying certain information such as the user organizations or the tariff classes. In addition, up to 120 units of value (240 units on a card with two tracks) are available as separate means of payment, which, as described below, are tested for validity and physically destroyed. The microstructure is protected by a sputtered metal coating and a lacquer coating. It provides optimum protection against forgeries and fraudulent manipulation.

The system security is based on holographic techniques used in conjunction with an optical card reader. In order



Fig. 6 The PHONOCARD is a more efficient telephone that is operated by prepaid cards. It provides the telephone administration with optimum security against fraud and vandalism and offers maximum convenience for the user.

to check the validity of the information carried by the value units, they are illuminated with a beam of infra-red radiation. This is reflected at certain angles depending on the chosen microstructure and checked by appropriate detectors. The information is converted into electrical signals, which are amplified and converted to digital form for evaluation by the microprocessor. If the information is correct, the payment process by erasure or destruction of the value units then takes place.

7.2 Reader

In order to prevent any manipulation, the value card is blocked after insertion in the reader. A stepper motor moves the read head and the erase head simultaneously over the card. After identification of the synchronization, the information is read and checked for validity by the microprocessor. If the information is accepted, the read head moves to the first valid value unit travelling over any value units which have already been erased. On the basis of the number of steps made by the reader, the remaining credit balance is calculated and displayed. If the credit balance is sufficient to make a call, the dialling mechanism is released. After the call has been established, the value units are destroyed by the erase head at the same rate as the metering pulses are received. Release of the card only takes place a few seconds after the replacement of the handset, so that metering pulse arriving at the end of the call can also be counted.

7.3 Security of the holographic system

In order to achieve optimum security, the system was not provided with reusable cards for the following reasons. When using rechargeable cards, equipment must be provided to enable the system users to recharge the empty

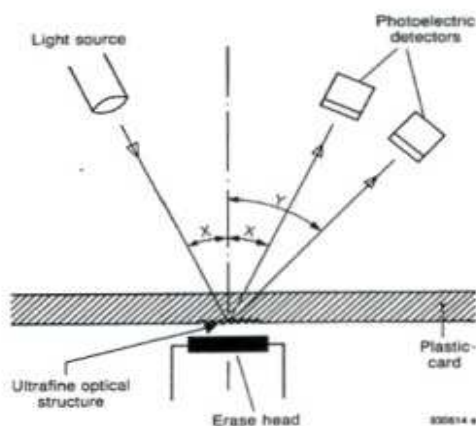


Fig. 7 The hologram is illuminated by a light source and the reflections are checked by detectors. If the PHONOCARD identifies the value units as valid, the telephone is released for making calls and the value units are erased at the same rate as the metering pulses are received.
X = angle of incidence, Y = angle of reflection

cards. For reasons of cost, series production has to be used to manufacture this equipment. However, too wide a distribution of such equipment renders the security questionable since lost or stolen equipment can get into the wrong hands and counterfeiting the cards would then be relatively simple.

With disposable cards, on the other hand, the physical destruction of the used value units makes it impossible for empty cards to be made reusable.

Further protection against forgery is provided by a coding technique that ensures the highest security and an expensive process for applying the optical microstructure to the card. The precision of the structure, which must be an order of magnitude better than the wavelength of the light used, is a further guarantee against copying.

7.4 Summary of the advantages of the PHONOCARD

1. The risk of breaking open is removed by the fact that the telephone contains no money or other means of payment.
2. The expenditure for the calculation of the call charges is extremely small, since the costs for collection in the machine, emptying cash-boxes, sorting, etc. are eliminated.
3. User convenience is optimum for both lengthy and brief calls. Calls are not cut off because of a lack of coins. Settlement is very precise for all kinds of calls.
4. Practical tests with the PHONOCARD have shown that longer and more frequent telephone calls are made, principally because of the increased convenience.
5. The cost of the disposable card, which is thrown away when it has been completely used up, is to a large extent recouped by the interest on the capital constituted by the payment in advance.
6. High security of the system against forgeries, recharging, manipulation, etc.
7. Not affected by modification or limited availability of the means of payment.

Author: Gottlieb Dändliker
Sodeco-Saia Ltd.
CH-1211 Geneva 16 (Switzerland)

Translator: Michael Malone
Grand-Lancy/Geneva (Switzerland)

www.optical-cards.com
Alain Knecht, June 2009