Sept. 29, 1970 D. M. HAM 3,531,627

TRANSIT TICKET HAVING FARE CODING MEANS FOR AUTOMATIC FARE COLLECTION SYSTEMS

Filed May 6, 1965 3 Sheets-Sheet 1

Fig. 1.

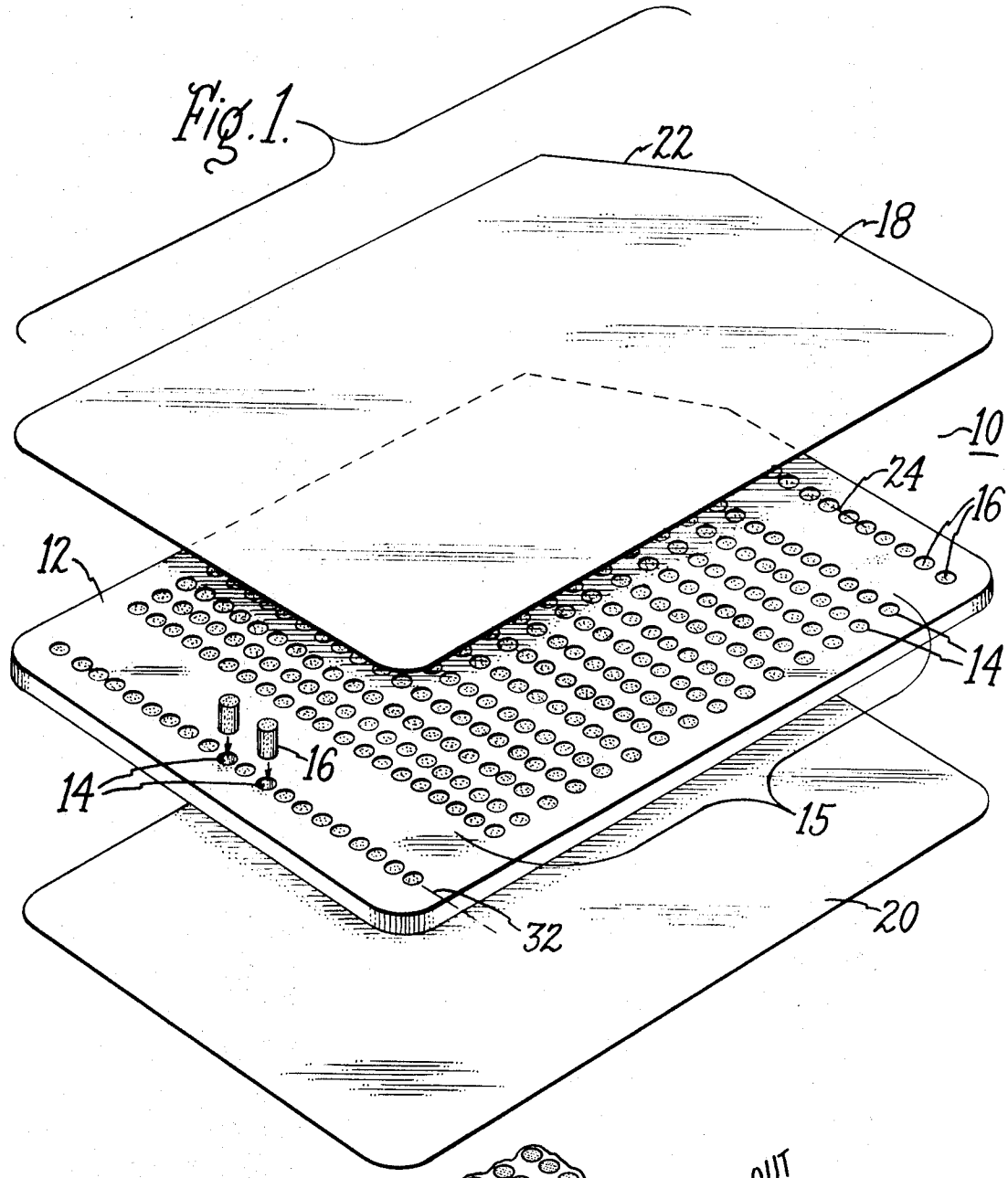
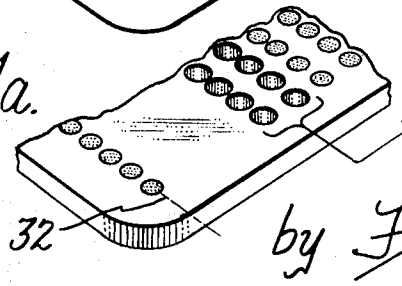


Fig. 1a.



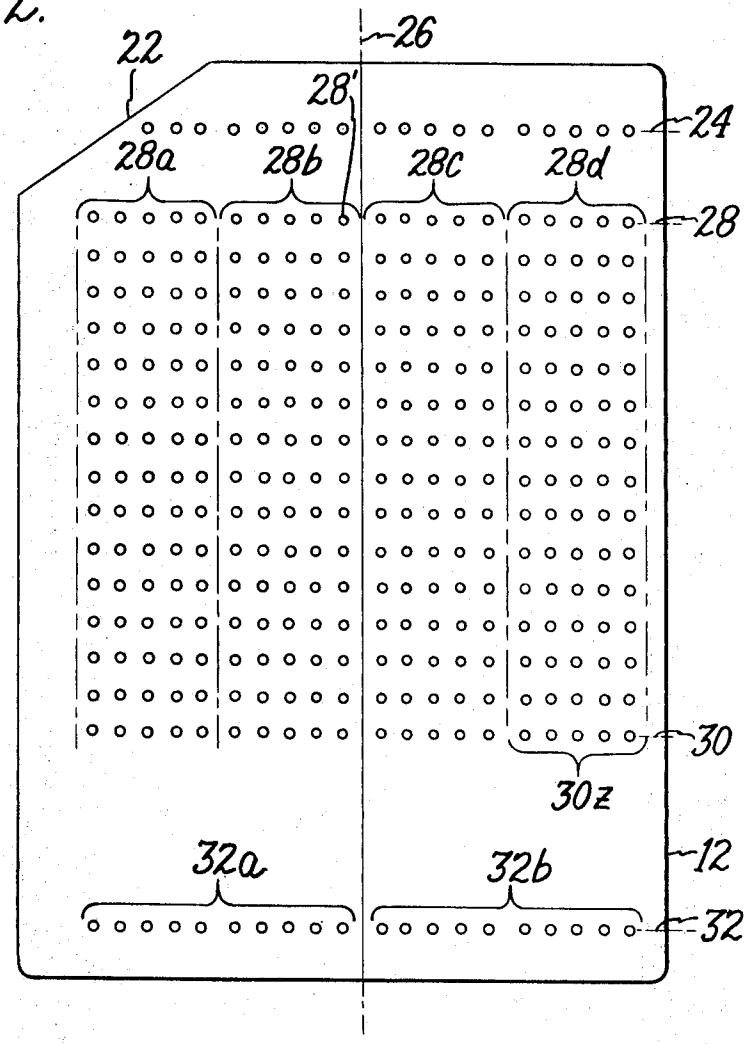
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TRANSIT TICKET HAVING FARE CODING MEANS FOR AUTOMATIC FARE COLLECTION SYSTEMS

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Fig. 2.



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Fig. 3.

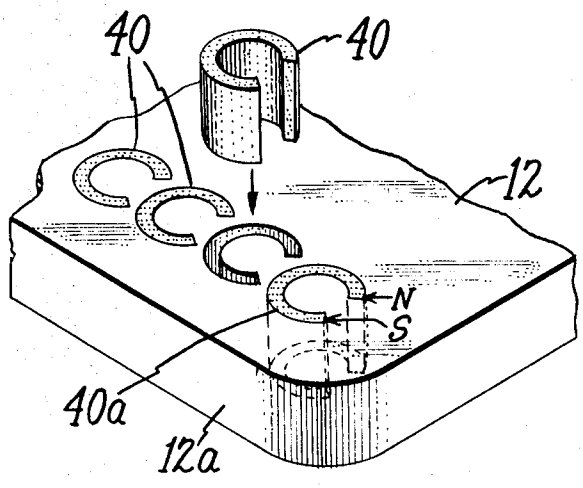


Fig. 4.

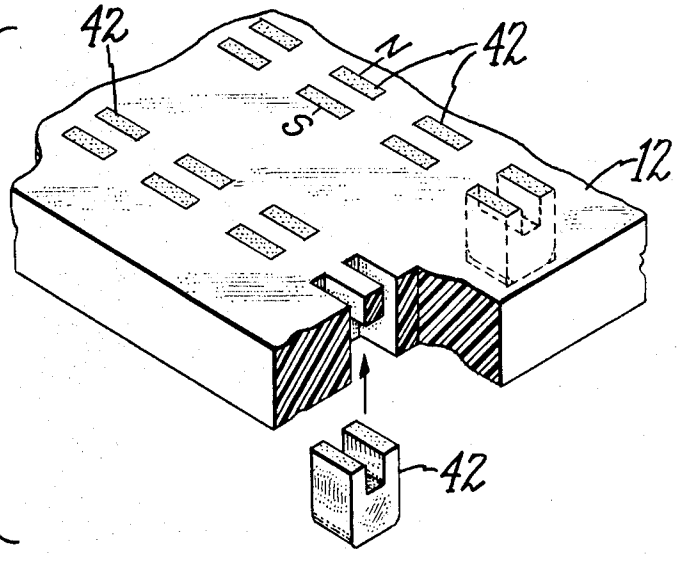


Fig. 5.

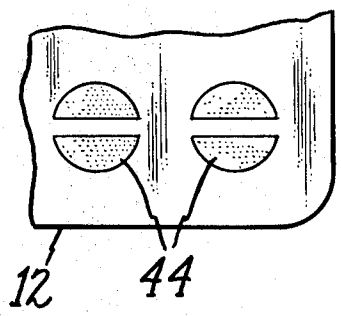
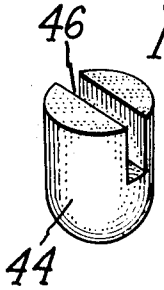


Fig. 6.



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3,531,627

TRANSIT TICKET HAVING FARE CODING MEANS FOR AUTOMATIC FARE COLLECTION SYSTEMS

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Int. Cl. G06k 19/06; H04q 3/02
U.S. Cl. 235—61.12 2 Claims

ABSTRACT OF THE DISCLOSURE

A transit ticket for use in automatic fare collection systems. The transit ticket has a core portion provided with a plurality of magnetic inserts adapted to be encoded with fare collection information. In one form, the magnetic inserts are grouped to provide fare coding to each station on the transit system. In another form, some inserts are used to represent prepaid fare and are adapted to be punched out as increments of the prepaid fare are used.

This invention relates to transit tickets and, more particularly, to a transit ticket having fare coding means for use in an automatic fare collection system.

Much interest has been expressed in recent years in rapid transit systems for moving a maximum amount of people in a minimum amount of time and space. The interest in these systems is increasing due to the growth of suburban communities surrounding large cities and the necessity of moving people from the suburbs into and out of the city, as well as within the cities. Traffic congestion in and around such cities has become an increasing problem, making it necessary to provide for greater use of rapid transit systems.

Most transit systems use either a single fare structure or a zoned fare structure. In a single fare structure the customer may enter the system at any station on payment of the single fare and may travel to any other station within the system. In a zoned fare structure the customer normally must purchase a special ticket which is generally only useable from the station where purchased to another specific station of the system. It it understood that many times tickets may be purchased at some central location for use at various stations of the system. The zoned fare structure is more complicated and costly to administer than is the single fare structure because it usually requires a plurality of tickets, a plurality of offices for issuing such tickets and transit system personnel, such as conductors, to be sure that the customer has properly paid the fare for the trip taken.

It has become increasingly evident that there is a need for a zoned fare structure to require each customer to pay according to his use of the transit system. It is also necessary to provide a zoned fare structure such that it is easy to use for the customer and is as automatic as possible. Preferably, it should be similar to a single fare structure in order to reduce the cost of operation as much as possible and to make it as easy as possible on the customer to utilize such transit system.

It has been proposed to provide a transit system using tickets and special types of turnstiles and ticket validators

to provide for automatic fare collection of a zoned fare structure. To make the system as simple, reliable and economical as possible, it is proposed to provide a complete fare structure on the tickets, thus requiring a minimum amount of logic in the validators of the system. One system of this type is described and claimed in patent application Ser. No. 453,715 filed concurrently herewith in the names of Donald M. Ham and Robert H. Jenks for System for Unattended Collection of Variable Fares, and which is assigned to the same assignee as this application. This invention provides a unique ticket for use in the automatic fare collection system of that application and other such systems, and may provide a complete fare structure on the ticket. It is also desirable to provide some time limit on the use of tickets within a rapid transit system wherein automatic fare collection is used. Thus, the ticket of this invention may also be provided with means on the ticket which may be coded for a time use in order to limit the time in which the ticket may be used within the transit system.

It is, therefore, an object of this invention to provide a novel transit ticket for use with an automatic fare collection system.

A further object of this invention is to provide a novel transit ticket having a complete transit system fare structure coded on the ticket.

A further object of this invention is to provide a novel transit ticket which is made of plastic or the like to provide a low cost, readily replaceable ticket which may be readily replaced, for example on the change of a fare structure.

It is a further object of the invention to provide a novel transit ticket wherein the ticket may be provided with provisions for time coding on the ticket.

Another object of this invention is to provide a novel ticket having an encodable magnetic matrix of discrete magnetic bits which may be encoded with desired fare information.

A still further object of the invention is to provide a novel transit ticket having a complete transit system fare structure thereon, which ticket may be readily re-used.

In carrying out this invention in one form a transit ticket is provided which may be used with an automatic fare collection system of a transit system. The ticket is provided with a coded matrix according to the transit system zone fare structure. The matrix is designed such that portions of the matrix may be encoded according to the entry station while other portions may be encoded with the fare to each exit station. The matrix is designed such that it will be readily encoded and decoded by an automatic fare collection system to insure that customers will pay the correct fare for their use of the transit system. If desired, time coding means may be provided on the ticket so as to be encoded and decoded according to the time allowed for a given trip. The time coding may be used to further insure that the customers do not try to misuse the automatic fare collection system.

In another form of this invention a ticket is provided having a coded matrix formed of a plurality of discrete magnetic bits. The bits may be encoded with any desirable fare information, such as entrance station, pre-paid fare and similar information. Where used as a prepaid fare ticket, portions of the prepaid fare may be canceled by

removal of a number of discrete bits, such as by punching them out of the ticket.

The invention which is sought to be protected will be particularly pointed out and distinctly claimed in the claims appended hereto. However, it is believed that a better understanding of the invention and its objects and advantages, as well as other objects and advantages thereof, may be obtained from a consideration of the following detailed description of a preferred embodiment thereof, especially when considered in the light of the accompanying drawings, in which:

FIG. 1 is an exploded perspective view of a preferred form of transit ticket made according to one form of this invention;

FIG. 1A is a partial perspective view of a portion of a ticket showing one means of canceling prepaid fare;

FIG. 2 is a plan view of one form of ticket coding which may be used according to this invention;

FIG. 3 is a partial perspective view of a modified form of ticket according to this invention;

FIG. 4 is a partial perspective view of a further modification;

FIG. 5 is a partial top view of a modification of FIG. 4; and

FIG. 6 is a perspective view of a magnetic insert for use in the modification shown in FIG. 5.

This invention relates to a transit ticket which may be used for automatic fare collection on rapid transit systems. While the invention will be described with particular reference to one type of automatic fare collection, as disclosed in aforesaid application Ser. No. 453,715, it will be understood that this description is for illustrative purposes only and should not be considered as limiting this invention.

As discussed in application Ser. No. 453,715, an automatic fare collection system may include an entrance turnstile for dispensing a transit ticket, a validator at an exit station for computing the fare owed for a ride on the transit system, and after receiving such fare validating the transit ticket, and an exit turnstile which will recognize a validated ticket and unlock to allow a customer to leave the exit station. This invention discloses a transit ticket which may be used in the fare collection system of that application. Of course, as will be understood, the transit ticket of this invention may also be used in other fare collection systems.

In a preferred embodiment of this invention the transit ticket is provided with a magnetic matrix, such matrix including a plurality of magnetic inserts. The inserts are embedded in the ticket with their axes perpendicular to the face of the ticket. The preferred matrix is designed for binary coding. Each magnetic insert is encoded as a zero or a one by driving the magnetic inserts to saturation in one of the two possible polarities relative to the face of the ticket.

FIG. 1 shows one form of transit ticket according to the preferred embodiment of this invention. The ticket, generally indicated at **10**, is comprised of a core member **12**, preferably of a plastic material such as vinyl. The core **12** is of any desired thickness, such as, for example, 0.025 inch. A plurality of holes **14** are drilled or punched in core **12**, as shown. Each hole **14** is filled with a magnetic insert **16**. As will be understood, the holes **14** could be formed during molding of core **12**, and then filled with a powdered magnetic material, such as alnico. The powdered magnetic material could be provided with any type of resinous binder, if desired. Thus, the term "magnetic inserts" includes both a rod type of insert or a magnetic powder insert. After the magnetic inserts **16** are placed or formed in the holes **14**, a plastic film is placed over the top and bottom of core **12**, such as top film **18** and bottom film **20**. The ticket **10** may then be subjected to heat and pressure to form a homogeneous structure. Preferably, one edge of the ticket, as at **22**, is cut to provide means for orientation of the ticket **10** in the fare collection equipment. Of course, as will be understood,

various matter may be printed on the top and bottom of the ticket, as desired, or additional laminations having printed material may be added. Obviously, a plastic ticket as described will be very durable and reusable in the system. Also, such ticket will be relatively inexpensive and readily replaced, as necessary or desirable.

As will be understood the magnetic inserts **16** provide a plurality of discrete magnetic bits which may be encoded with any desired information. In one form of this invention it is proposed to use the ticket **10** as a prepaid commuter ticket. In such use, the ticket **10** would have a plurality of bits, such as indicated at **15**, in the body of the ticket used to designate prepaid fare. For example, there could be 100 bits in the group **15**. If each bit were assigned a value of five cents, then the ticket **10** would have a prepaid value of five dollars. If each bit were assigned a value of ten cents then the prepaid value would be ten dollars. Obviously, as many bits as desired could be used, and they could be assigned any desirable value. It will also be apparent that different rows of bits could be assigned different values, if desired. The upper row **24** could be used to indicate the validation of the ticket for exit. The bottom row **32** may be used to encode the entrance station, and the exit station, if desired.

In the use of ticket **10** as a prepaid commuter ticket, the ticket would be purchased prior to entering the transit system, such as from a central office. On entering the transit system, ticket **10** would be encoded, such as in a portion of line **32**, with the code of the entrance station. At the exit station a commuter ticket validator, would decode the entrance station information and then compute the fare due. The fare due would then be deleted from the prepaid fare of group **15**, such as by punching out some of the bits as shown in FIG. 1A. The ticket would then be validated in row **24** and returned to the customer. After validation, ticket **10** would be used to exit through the exit turnstile in the usual manner.

As will be apparent, the coded matrix of ticket **10** could be used to encode any desirable information. In a preferred form of the invention, ticket **10** is used entirely within the system and is provided with a coded matrix which contains the entire fare structure of the transit system.

One form of coded matrix which may be used with the ticket of this invention is shown in FIG. 2. Only the core **12** of a ticket **10** is shown. Core **12** is provided with a plurality of rows of magnetic bits or inserts **16**. In the embodiment shown, each row except one, contains twenty bits. The top row **24**, will only contain eighteen bits due to the cut edge **22**, as shown. The bits in row **24** will be divided into two groups, the ten bits to the right of center line **26** being used for validation of the ticket, while the eight bits to the left of center line may be used to indicate a fare paid by a credit card.

The next rows on the ticket are used to indicate the fare to be collected. Each row of twenty bits may be divided into five bit groups, each group designated as a station on the transit system. For example, considering row **28**, the first group of five bits, **28*a*** may be designated as station A, group **28*b*** may be designated as station B, group **28*c*** may be designated as station C and group **28*d*** may be designated as station D. Thus by using fifteen rows of twenty bits, as shown, a system having eighty different stations may be represented on the coded matrix. Thus the coded matrix shown in FIG. 2 may be used on any transit system having not more than eighty stations. Of course, it will be apparent that for transit systems having more than eighty stations, further rows would be added, each row being used to designate four different stations. It will also be apparent from FIG. 2 that each station of the transit system will have a unique group of five bits within the matrix of ticket core **12**. Thus group **28*a*** could represent the first station on the system while group **30Z** in row **30** could represent the last station on the system.

In the preferred embodiment shown in FIG. 2, a five bit group has been shown for each station. By use of a five bit binary code, fares from 5¢ to $1.55 may be encoded as is shown in the following table:

TABLE

	80¢	40¢	20¢	10¢	5¢
Fare:					
.05	0	0	0	0	1
.10	0	0	0	1	0
.15	0	0	0	1	1
.20	0	0	1	0	0
.25	0	0	1	0	1
.30	0	0	1	1	0
.35	0	0	1	1	1
.40	0	1	0	0	0
.45	0	1	0	0	1
.50	0	1	0	1	0
.55	0	1	0	1	1
.60	0	1	1	0	0
.65	0	1	1	0	1
.70	0	1	1	1	0
.75	0	1	1	1	1
.80	1	0	0	0	0
.85	1	0	0	0	1
.90	1	0	0	1	0
.95	1	0	0	1	1
1.00	1	0	1	0	0
1.05	1	0	1	0	1
1.10	1	0	1	1	0
1.15	1	0	1	1	1
1.20	1	1	0	0	0
1.25	1	1	0	0	1
1.30	1	1	0	1	0
1.35	1	1	0	1	1
1.40	1	1	1	0	0
1.45	1	1	1	0	1
1.50	1	1	1	1	0
1.55	1	1	1	1	1

Thus any fare may be encoded in each group of five bits within the limit of the code, which is equal to the fare for that station from any other station of the transit system.

For example, consider a customer entering the transit system at station A. The customer would receive a ticket **10** from the entrance turnstile. This turnstile would be designed to encode each ticket **10** with the correct fare to every station in the system. Thus if the fare to station B were 5¢, then bit **28'** would be encoded as one and the other bits of group **28***b* encoded as zeroes. If the fare to station Z were $1.55 then all bits in group **30**Z would be encoded as one. Obviously, all other five bit groups would be encoded in a similar manner to indicate the fare from station A. Of course, the five bits in group **28***a* would all be encoded zero since there would be no fare from station A to station A. From this example it will be apparent that ticket **10** may be used to provide in binary coded form the fare from any one station of a transit system to all other stations in the transit system. Of course it will be obvious to those skilled in the art, that the binary code selected will depend on the fare structure. Using the five bit code and a 10¢ increment, a fare structure may be provided from a minimum of 10¢ to a maximum of $3.10. Obviously, a code could be used, having more or less bits for each station, according to the fare structure of the particular transit system. Therefore, while a five bit code has been specifically described, it will be understood that such description is for illustrative purposes only. Also, as will be understood, it is not necessary that the bits representing a station be adjacent. To make the ticket more difficult to copy, any five bits could be selected to represent a station.

Still referring to FIG. 2, a final line of magnetic inserts is provided as indicated at **32**. In the preferred form of this invention, the group of ten bits **32***a* to the left of center line **26**, is used to encode the code designation of the entrance station. With the entrance station encoded at this part of the ticket, a transit employee, such as a station agent, would be able to check a passenger's ticket, and with a fare table readily ascertain the appropriate fare for any exit station. By this means, a station agent could readily determine the entrance station from which a ticket was obtained and assure a passenger that the required fare was correct and that the fare collection equipment was functioning properly.

The ten bit group **32***b* to the right of the center line **26**, may be used as a time encoding means. As will be understood, it may be desirable to limit the time that a passenger has to complete a ride within the transit system. The use of time limits is considered desirable to prevent abuse of the system. Therefore, the ten bit group **32***b* may be encoded with the time of entrance of a passenger into the transit system. At the exit station, the ticket validator could check the entrance station code at **32***a* and calculate from system logic the allowed time to that particular exit station. This allowed time would be subtracted from the time at which the ticket was presented. This time would then be compared with the entrance time coded at group **32***b*, and if a comparison was obtained then the ticket would be time valid. Of course, if no time limit is desired, group **32***b* may be left off the ticket, or used for other information.

The ticket of this invention may also be used with a credit card in a transit system. In such instances any row of twenty bits which does not include the exit station fare for the exit station used may be used to encode the account number of the credit card. Where this is used it may also be desirable to use group **32***b* to encode the exit station code. In this way the ticket **10** could be used directly with billing machines to bill credit card customers for their use of the transit system.

Referring now to FIG. 3 of the drawing, a modified form of ticket is shown. In this form of ticket a horseshoe-shaped magnetic insert **40** is shown in core **12** of a ticket. In this type of ticket the cavities formed in core **12** would be horseshoe shaped and magnetic powder could be used to fill such cavities in the same manner as discussed with reference to FIG. 1. Of course, such cavities could be punched in the core **12**, or formed therein during the molding of the core **12**. As will be apparent the encoding would be accomplished by magnetizing the inserts **40** with the north pole either toward the top edge of the ticket or toward the bottom edge **12***a* of the ticket to indicate a zero or a one, as desired. For example, bit **40***a* is shown with the north pole N toward the top of the ticket and the south pole S, toward the bottom edge of the ticket. Obviously, this could be either zero or one, as desired.

FIG. 4 shows a modified form of horseshoe shape magnetic insert. In this modification the insert is formed so that both ends of the magnetic insert **42** lie in the upper surface of the core **12**. As will be apparent, the same method of encoding may be used.

FIGS. 5 and 6 show another modified form of horseshoe-shaped magnetic bits or inserts. In this form, the insert **44** is shown as a cylindrical member with a slot **46** forming the north and south pole portions of the magnetic insert. As shown in FIG. 5, both the north and south pole portions of magnetic insert **44** will lie on the surface of the core **12**. The manner of encoding bits **44** may be the same as described previously.

From the above description it will be apparent that by means of this invention there is provided a transit ticket which may be used in an automatic fare collection system of a rapid transit system. The ticket of this invention may include the complete fare structure of the transit system in the body of the ticket so that it may be readily encoded and decoded by elements of fare collection equipment to collect the correct fare for any possible ride on the transit system. With the ticket of this invention there is no requirement for the customer to determine the appropriate fare and buy a correct fare ticket before entering the system. The ticket is especially suited for a pay-on-exit system as described. Also, as described, the ticket of this invention readily lends itself for use as a prepaid commuter ticket. As will be understood, by use of magnetic inserts, the ticket may be used with static read and write equipment, thus providing for less com-

plex fare collection equipment. Thus while there has been shown and described the present preferred embodiment of the ticket of this invention, together with modifications thereof, it will be apparent that various changes may be made in the construction of the ticket without departing from the spirit and scope of the invention, particularly as it is defined in the appended claims.

What is claimed as new and which it is desired to seecure by Letters Patent of the United States is:

1. A transit ticket for use in an automatic fare collection system of a transit system comprising:
   (A) a ticket member;
   (B) said ticket member including a core portion;
   (C) a coded matrix in said core portion, said coded matrix comprising a plurality of discrete magnetic inserts mounted in separate holes formed in said core portion;
      (1) a portion of said coded matrix including a plurality of rows, each row containing an equal number of discrete magnetic inserts;
   (D) said core portion being a plastic material selected to enable said discrete magnetic inserts to be punched out of said rows on use of said ticket.

2. A transit ticket for use in an automatic fare collection system of a transit system as claimed in claim 1 in which said plastic core portion is sandwiched between opaque plastic layers.

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U.S. Cl. X.R.

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