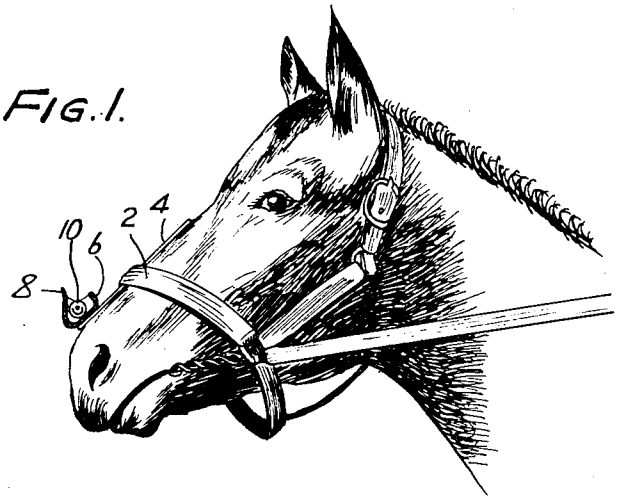
March 12, 1946. G. MILLER 2,396,280

RACE TRACK DEVICE

Filed Feb. 15, 1941 2 Sheets-Sheet 1

FIG. 1.



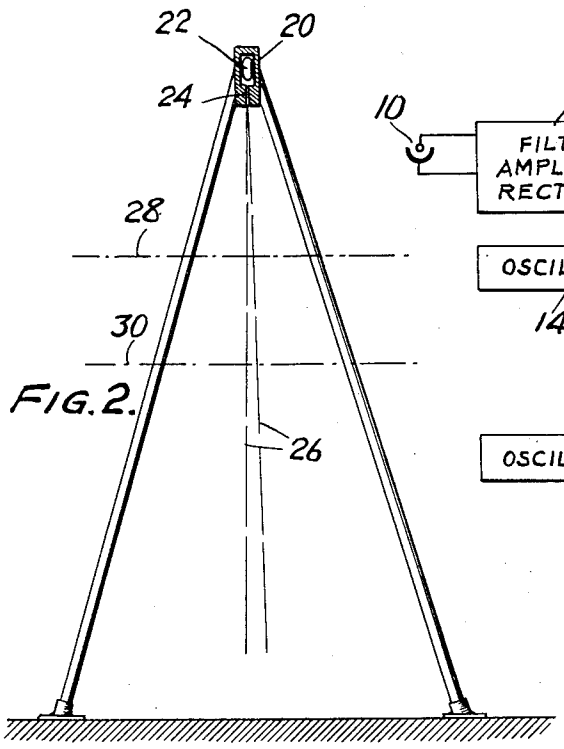




FIG. 2.

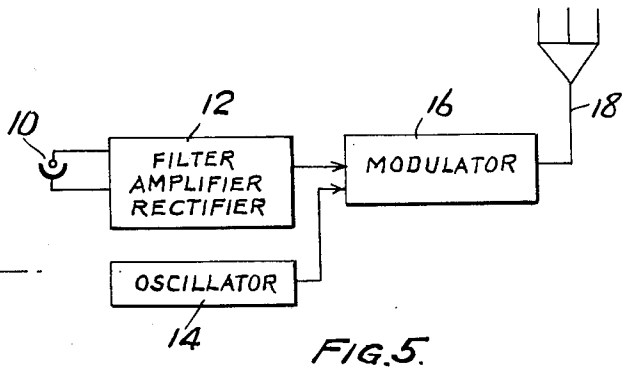



FIG. 5.

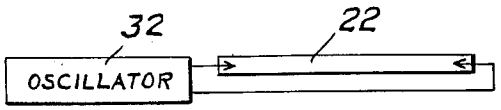



FIG. 6.

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WITNESS:

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RACE TRACK DEVICE

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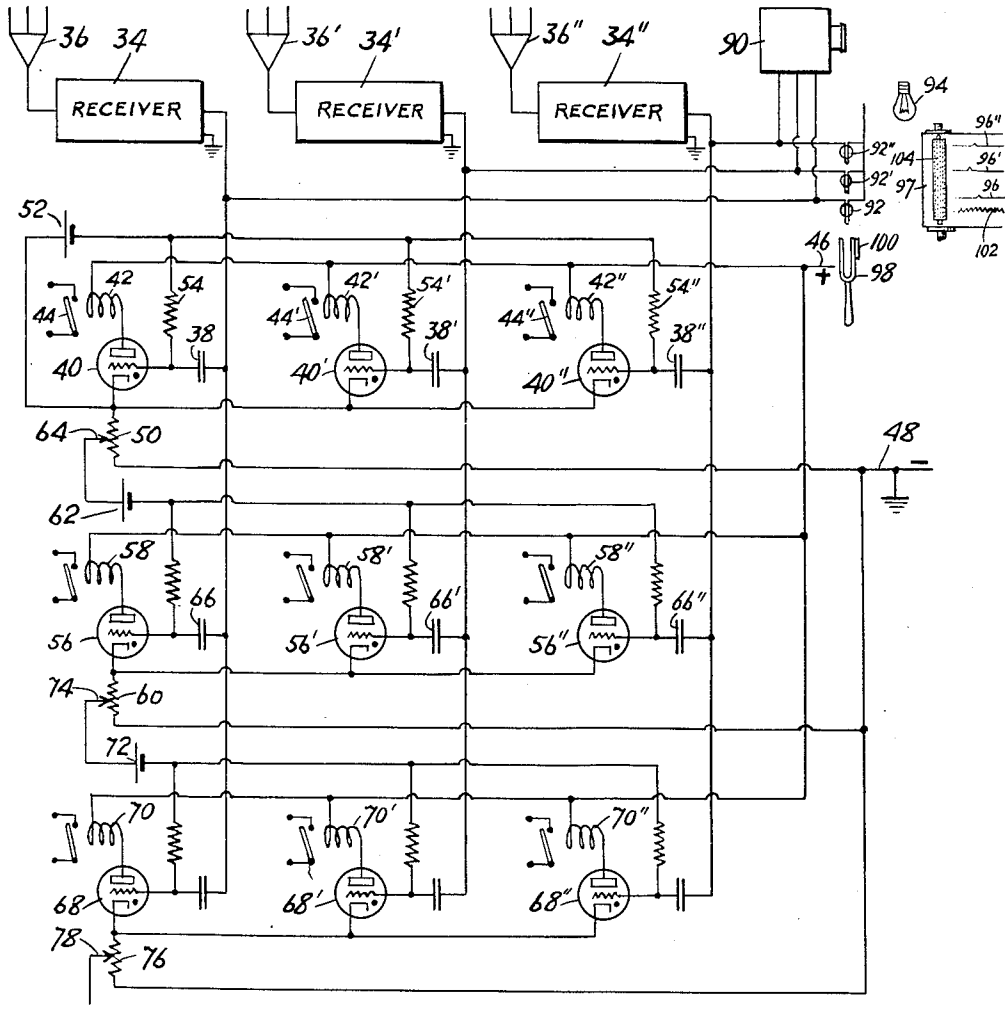



FIG. 3.

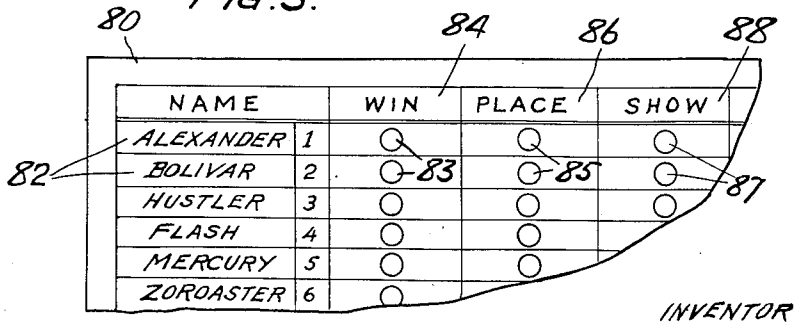



FIG. 4.

WITNESS:

INVENTOR

George Miller

BY

ATTORNEYS.

Patented Mar. 12, 1946

2,396,280

# UNITED STATES PATENT OFFICE

2,396,280

## RACE TRACK DEVICE

George Miller, Philadelphia, Pa., assignor of one-half to Jesse B. Hudson, Philadelphia, Pa., and one-half to Albert L. Kusner, Lansdowne, Pa.

Application February 15, 1941, Serial No. 379,143

7 Claims. (Cl. 177—311)

This invention relates to racetrack apparatus and particularly to means for recording the order of arrival of contestants in a race, for example, horses or dogs.

At the present time, racetracks are equipped at their finish lines with photographic apparatus for the purpose of recording the relative positions of the contestants as they approach and cross the finish line. While in most races the judges can determine beyond question the order of arrival, there sometimes occur the close, so-called "photo-finishes," in which the successive arrivals are so close that dependence must be had on the records of the photographic apparatus to determine the order of arrival. While apparatus of such type is quite satisfactory to eliminate controversy, nevertheless, photographic development is required, and as a consequence, the determination of the order of arrival is substantially delayed.

The broad object of the present invention is to provide apparatus whereby the arrivals are automatically recorded in proper order even though successive arrivals may differ by only a very small fraction of a second. In its more specific aspect, the invention relates to a type of device which will record the order of arrival instantaneously on a board visible to the spectators of a race.

The above objects, and more specific objects relating to details of the apparatus, will become apparent from the following description, read in conjunction with the accompanying drawings, in which:

Figure 1 is a perspective view showing in vertical section a device carried by a race horse to record a finish;

Figure 2 is a vertical section taken transversely to a member located at the finish line forming part of a preferred form of apparatus;

Figure 3 is a wiring diagram illustrating certain detecting and recording apparatus;

Figure 4 is a fragmentary view of a type of board used for exhibiting the order of arrival;

Figure 5 is a schematic diagram showing the nature of certain apparatus carried by the racing animal; and

Figure 6 is a schematic view of apparatus located at the finish line.

Though the invention may be used for various kinds of races, it is particularly adaptable to horse races, and will be specifically described with relation thereto.

In accordance with the invention, the horse carries certain apparatus adapted to cooperate with other apparatus at the finish line to determine the instant of the finish and to effect the recording thereof. In a preferred embodiment of the invention, the horse carries a photocell on his nose arranged to be energized as it passes through a beam of light projected downwardly across the track at the finish line. As illustrated in Figure 1, there is secured to a portion 2 of the head harness of the horse a plate 4 arranged to rest on the horse's nose and carrying at its forward end, desirably in a position substantially vertically above the tip of the horse's nose when its head is in a normal position assumed while running, a housing 6 open at the top in which is located a photocell of small size having its sensitive surface directed upwardly. The front of this housing 6 may be elevated as illustrated at 8 to provide a shield against mud and dust to prevent, as far as possible, any soiling of the photocell surface which might result in rendering it inoperative. The photocell may be of any suitable type capable of proper response to light modulated at high frequency.

The equipment illustrated in Figure 5 is carried by the horse taking the place of one or more of the usual weights carried by a horse in racing. The output of the photocell is fed into an apparatus of any suitable type, indicated at 12, which may comprise a filter, amplifier and rectifier. The output of this controls, in the modulator 16, the output of an oscillator 14 to deliver a pulse of high frequency to an antenna, indicated at 18, which may be constituted by metal fittings about or in a portion of the horse's harness. The equipment illustrated in Figure 5 may be quite light, powered by small batteries, and may have a radio frequency output of very low power.

The apparatus of Figure 2 at the finish line comprises a housing 20 in the form of a hollow bar extending completely across the track. Located within this are one or more gas-filled tubes 22, which may be of the type generally used for illumination, filled with neon, argon or other gas. A slit 24, or more complicated optical arrangement, is located in the lower portion of the bar 20 to project downwardly from the tube a sheet of light extending completely across the track and limited between planes such as indicated at 26. The arrangement is subject to considerable variation, but desirably the sheet of light should be as thin as possible or, at any rate, have its side toward which the horses approach substantially vertical so as to define accurately the finish line. Planes indicated at 28 and 30 may

substantially delimit the upper and lower possible positions of the photocells on the horses' noses, and consequently the portion of the sheet between these planes will be that intercepted by the photocells as the horses finish and consequently should be located and dimensioned within the proper limits.

The objective of the apparatus so far described is to have the photocell respond to the sheet of light indicated at 26 and, through the apparatus of Figure 5, send out a high frequency pulse to be detected by apparatus later described. In view of the fact that the race may be run in sunlight, it is obvious that some arrangement must be provided to insure selective response of the photocell to the light from the tube 22 as compared with the light of the sun or sky. For this reason, it is desirable to illuminate the tube 22 as indicated in Figure 6, by means of a high frequency oscillator 32, which will provide modulation of the sheet of light at 26 at the frequency of the oscillator. The oscillator 32 must provide a frequency of light molulation sufficiently high so that at least several cycles will occur during the limited time in which the photocell on a horse's nose will be passing through the sheet of light 26; or more properly through the limited time corresponding to the passage of the photocell through the maximum distance to be tolerated in avoiding other than a "dead-heat" finish. For example, if a tolerance of one inch is permitted at the finish line, the frequency of the oscillator must be such that at least several cycles occur during the interval of passage of the photocell through this inch. It will be evident that the oscillator should operate at a quite high frequency of the order of at least several kilocycles.

Referring now to Figure 5, the filter embodied in the apparatus indicated at 12 is necessary to select the modulating frequency of the tube 22 from the constant source or such other modulating frequencies as might possibly exist, due, for example, to alternating current, artificial lighting or the like. The filter may, therefore, be of a type embodying one or more simple resonant circuits tuned to the light-modulating frequency. The output of the filter may then be suitably amplified and ultimately rectified so that the output of the apparatus 12 to the modulator may be a D. C. pulse fed to the modulator 16. The circuit arrangement should be such that a transient, produced, for example, by the passing of the photocell into or out of the shadow of the bar 20 cast by the sun, will not create a pulse affecting the modulator. The modulator may comprise an amplifying stage normally biased substantially to cut-off so as not to pass high frequency from the oscillator 14, until the bias is removed by the D. C. pulse from the apparatus 12. The result will be, therefore, a pulse of short duration at high frequency in the antenna 18 as the horse passes the finish line. To distinguish between the horses, the oscillator 14 carried by each horse has a distinctive frequency controlled, for example, by a crystal which, as will be pointed out hereafter, may be checked by the judges of the race. The frequencies used may be in the so-called short wave bands and should be sufficiently separated so that the various horses may be distinguished without question by their characteristic frequencies. The result of this arrangement is that as each horse passes the finish line a pulse of characteristic frequency will be transmitted to a detecting and recording apparatus illustrated in Figure 3, now to be described.

The detecting and recording apparatus of Figure 3 may be located in the judges' stand adjacent the finish line and comprises in the form illustrated a series of tuned receivers 34, 34' and 34'', one for each horse, permanently tuned to the frequency of the oscillator carried by the corresponding horse. Suitable antennae 36, 36' and 36'' serve to pick up the high frequency pulses from the various horses.

The outputs of the respective receivers, which may be high frequency, low frequency, or D. C., are delivered through condensers 38, 38', 38'' to the grids of gas tubes 40, 40' and 40'' of a first set adapted to record the winner of the race. These gas tubes may be of any conventional type (such as RCA 885 or 2050) adapted to break down and pass current by ionization when a sufficiently positive pulse is applied to the tube grid. The plates of the tubes are connected through relays 42, 42' and 42'' to the positive terminal of a high voltage D. C. source, indicated at 46. The negative terminal 48 of the source is connected through a resistor 50 to the cathodes of the various tubes which are connected together. The relays just mentioned have respective armatures 44, 44' and 44'' adapted to be attracted to close controlled circuits when current passes through the relay coils. Desirably these coils are of low impedance so as not to provide substantial time delay in the attainment of maximum current values in the tubes when break-down occurs; or, if extremely rapid action is desired, the relay coils may be replaced by resistors, the voltage drops through which may operate the relays through amplifying vacuum tubes. A battery, indicated at 52, serves to bias the grids of the tubes normally to a sufficiently negative degree to prevent ionization from occurring. Load resistors 54, 54' and 54'' are provided between the grids and the biasing battery.

A second series of tubes 56, 56' and 56'' are provided to record the horse arriving second. As in the case of the tubes 40, 40' and 40'', the plates of these tubes are connected to the positive terminal of the high voltage source through relays 58, 58' and 58'', also provided with armatures. Pulses may be delivered to these tubes through the condensers 66, 66' and 66''. In the case of this second group of tubes, the bias is provided by a battery 62, in this case biasing the grids to a greater negative degree than in the case of the tubes 40. The grid circuits return to an adjustable tap 64 on the cathode resistor 50 of the previous group of tubes.

This same type of connection is repeated for a third group of tubes 68, 68' and 68'' provided with relays 70, 70' and 70''. Their grid bias is provided by a battery 72, the return connection being made to the tap 74 on the cathode resistor 60 of the preceding group of tubes. The last group of tubes 68, 68' and 68'' is provided with a cathode resistor 76 to which, as indicated at 78, may be connected the grid returns of a subsequent series of tubes. The number of series of tubes used depends entirely on how many arrivals it is desired to record. There may be recorded only the first three or first four, though in some instances it may be desirable to record the entire field to avoid any question of the proper operation of any part of the apparatus. The number of columns of tubes illustrated in Figure 3 must, of course, be equal to the number of horses, and while only three are illus-

trated, it will be evident that the array may be repeated to any necessary extent.

The apparatus illustrated in Figure 3 may be associated with a remotely located board, indicated at 80, for announcing the arrivals to the spectators. This board may be provided with the names and numbers of the racing horses and with columns of lamps 83 in a "win" column 84, lamps 85 in a "place" column 86, and lamps 87 in a "show" column 88. These columns may, of course, be continued as far as desired to show fourth and later arrivals. The lamps may be directly connected to the armature circuits of the various relays above described.

Disregarding for the present the apparatus illustrated at the upper right hand portion of Figure 3, the detecting and recording devices operate as follows:

Assume that the horses arrive in the order corresponding to the receivers 34, 34' and 34'', respectively. As soon as the horse corresponding to receiver 34 intercepts the sheet of light 26, a high frequency pulse will be transmitted by the equipment he carries and will be amplified in the receiver 34 tuned to his characteristic frequency. The output of the receiver delivers a pulse to the grids of all three tubes 40, 56 and 68, and such additional tubes as may be provided connected to the receiver 34. As pointed out above, however, the grids of tubes 56 and 68 and subsequent tubes are biased to such extent that the pulse delivered by the receiver 34 will be insufficient to cause a break-down of these tubes, and consequently, tube 40 alone will break down, this breakdown occurring substantially simultaneously with the crossing of the finish line. It is characteristic of gas tubes that when break-down occurs and they pass substantially their rated currents, the voltage between anode and cathode drops to a quite low value. For example, while the voltage may be initially several hundred volts, the voltage that occurs at break-down may be of the order of 15 to 50 volts. The current is limited by the relay 42 (or a resistance in its location) and the resistance 50. If the relay 42, therefore, (or a resistance in its location) does not have a very high impedance in comparison with the resistance 50, the voltage between the plates and cathodes of all three tubes 40, 40' and 40'' will drop to a comparatively low value. The adjustment is such that with this low value of plate voltage impulses of the magnitude delivered by the receivers 34', 34'', etc. will not be sufficient to break down the tubes 40' and 40''. As a consequence, as soon as one of these tubes breaks down, the other tubes of the "win" group become inoperative and non-responsive to subsequent impulses.

As soon as the tube 40 breaks down, its cathode current flows through the resistor 50. This adds a positive potential, due to the voltage drop in the resistor 50 below the tap 64, to the negative biasing potential provided by the battery 62, and the adjustment is so made that this is sufficient to lower the negative biasing potential on the grids of the tubes 56, 56' and 56'' to such extent that the tubes may now be broken down by an impulse delivered by any one of the receivers. The horse corresponding to receiver 34 having passed, there will, of course, be no tendency to break down the tube 56. But now, assuming that the horse corresponding to receiver 34' arrives at the finish line second, the tube 56' will break down producing energization of its relay 58'. At the same time, due to the reduction of potential between the plate and cathode of this tube, the other tubes of the same row in Figure 3 are rendered inoperative to respond to further impulses. Simultaneously, however, due to the voltage drop through the cathode resistor 60, the negative bias on the third group of tubes 68, 68' and 68'' is reduced so that these tubes promptly become operative and subject to response to the receivers connected thereto.

It may be noted that, due to the small inductance interposed in the plate circuit of each tube by its relay 42, there will be a very slight but appreciable delay between the initiation of discharge in a tube and the rendering responsive of the tube directly below it in its column. Accordingly, only the uppermost operative tube in a column will break down due to a corresponding impulse without the same occurring in the lower tubes of the column. If the impulse delivered to the grids lasts throughout the total time of passage of the photocell through the sheet of light, the sheet should be quite thin so that the arrival of one horse may not break down several tubes in a column. But any such danger may be avoided, and very close finishes recorded, if the impulse delivered to the grids is, for example, caused by a transient voltage produced by discharge of a gas filled tube forming the last stage of each amplifier. In such case, irrespective of the duration of subjection of the photocell to the activating light, the pulse delivered will be only of very short duration.

As the tubes break down, their corresponding relays will operate to close the circuits to the various lamps 83, 85, 87 etc. It will be noted that delays in the action of these relays have no limiting factors on the rapidity of response on the circuit of Figure 3. In other words, considering very small time differences, it is quite possible that three tubes may break down in succession before the relay of the first may be completely closed to flash the light on the board. The system is completely free from delays due to mechanical lag, inasmuch as advantage is taken of the extremely rapid break-down of the gas-filled tubes. Since discharge of such tubes once started continues until the plate voltages are removed or sufficiently lowered, it will be evident that the relays close permanently to maintain the proper lamps lighted on the board 80.

It may be desirable to provide a master switch controlling the circuits including the armature relays and the indicating lights or the equivalent, this switch being subject to manual operation. This is desirable if the race terminates in what appears to be a dead heat with the result that the judges may wish to check a permanent record, hereafter described, to insure that the finishes were not so close as to result possibly in improper operation. The main switch just referred to may be normally open, and its closing immediately after the end of the race may be under control of the judges. If the apparatus appears to have functioned properly, the switch may be closed immediately. The relays may, of course, be connected to indicate the results on a private board available to the judges, who can then duplicate the indications on a board visible to the public if their private board indicates proper results. In any event, it will be noted that the break-downs of the tubes themselves indicate the order of arrivals, and if they are arranged so that their visible glows are observable, they themselves may function to provide the private indication for the judges.

In order to secure a permanent record, the apparatus so far described may be associated with other elements. For example, the various receivers such as 34, 34' and 34'' may be connected to a camera having its axis directed across the finish line, the camera being of a motion picture type with provision for making an exposure upon each new impulse from a receiver. Thus a separate picture may be taken of the field as each horse crosses the finish line. The photographic records thus obtained may be permanently filed as a record of the nature of each finish.

Additionally, it is desirable to secure a permanent record available within a minute or so of the end of the race indicating minute time intervals indicating to a high degree of accuracy the times of arrivals of the various horses. This may be accomplished by providing an oscillograph mirror for each of the receivers as indicated at 92, 92' and 92'', there being, of course, a number of these equal to the number of contestants. A lamp, indicated at 94 may be provided to cause beams from these mirrors to fall on a photographically sensitized paper, indicated at 97, moving in the direction of its length. The beams falling on this record member will normally trace straight lines, but as an impulse occurs upon the arrival of a horse, the line will be interrupted as the oscillograph mirror moves. Simultaneously, a timing record can be provided by reflection of a beam of light from the mirror 100 of a tuning fork 98 maintained electrically in vibration and arranged to produce on the record sheet a sinusoidal trace 102 serving to mark time intervals. The apparatus indicated need not be more fully described, since it may be identically the type of apparatus conventionally used in seismographic prospecting for oil or other minerals. In such devices the tuning fork may record intervals of a thousandth of a second and breaks in the continuous lines will indicate the receiving of impulses. There will be, of course, one line for each contestant. In the present case, since development as soon as possible is desired, the photographic paper may be subjected immediately beyond the line where the light beams strike it to the action of a photographic developer applied, for example, by a roller indicated at 104. A rapid developing agent bringing up the latent image within less than a minute may be employed. The record sheet as the developing takes place may pass under an amber glass in the otherwise light-tight container, so that the records may be observed as soon as the partial development takes place and prior to fixing, which may also take place automatically. Thus immediately after the end of the race the judges may look at the record sheet undergoing development and note whether there are sufficient intervals existing between indicated arrivals to warrant their making a decision as to the positions of the horses. Of course, if the intervals indicated are within the limits of error of the apparatus, a dead heat may have to be announced.

Suitable precautions must, of course, be taken to avoid fraud. The transmitting apparatus carried by the horses should be checked and sealed, and, to insure against falsification of frequencies, these may be determined by crystals sealed in the apparatus. Likewise, the receivers may contain sealed crystals acting as filters to insure that each receiver responds only to the frequency of the corresponding contestant. The recording apparatus as a whole should, of course, also be sealed. Both at the beginning and end of the race, the apparatus carried by each horse should also be checked to insure that it was in proper working condition during the race. It will be evident that alternative arrangements may be provided within the scope of the invention. For example, instead of having a light sensitive element carried by the contestants and a light source at the finish line, the arrangement may be reversed. Each of the horses may carry a light of the gas type modulated at a characteristic frequency, while at the finish line a battery of photocells may be provided to detect light through a limited extent of field corresponding, for example, to the region between the lines 26 of Figure 2. In such case, the battery of photocells arranged in parallel may be wired to a detecting apparatus capable of distinguishing between the various frequencies at which the respective lights carried by the horses are modulated. In general, in such case the receiving and detecting apparatus may be the same as already described.

Alternatively, lights may be carried by the horses modulated at the same frequency, but the various lights may be provided with filters capable of passing narrow ranges of illumination. At the finish line, in such case, photocells may be provided forming the various groups, the photocells of each group being provided with similar filters so as to detect only the radiations from a single horse. Again the recording apparatus may be substantially similar to that described herein.

The detection of the finish may also be accomplished in other ways. For example, a large coil may be provided at the finish line through which the horses will pass. If this coil carries currents at a number of different frequencies, the horses may be provided with coils tuned by fixed condensers, carried on their noses. Each of these tuned circuits should be tuned to one of the frequencies carried by the coil at the finish line. The result will be that a short-circuiting secondary will be provided corresponding to each frequency as successive horses pass the finish line. The presence of such short-circuiting secondary may be readily detected to affect the source of corresponding frequency. The recording apparatus may again be similar to that illustrated in Figure 3.

The apparatus described, or its modifications, may be provided not only at the finish line, but, if desired, at the starting line, and even at various other points about the course to determine the order of arrival of the contestants at various locations. If used at both starting and finish lines, the contestants may be credited with actual elapsed time between the two lines as compared with the present arrangement in which failure to get off to a proper start may reflect to the discredit of the faster contestant. In fact, in such case, the winner of the race may be determined by the minimum elapsed time between the starting and finish lines rather than the first arrival at the finish line, irrespective of the nature of the start.

It will be obvious that other variations may be utilized in accordance with the principles of the invention without departing from its scope.

What I claim and desire to protect by Letters Patent is:

1. Apparatus for determining the order of arrival of race contestants at a finish line comprising means substantially defining an upright plane at the finish line, means carried by each

contestant in the race, one of said means comprising a light source and the other a detector of light from said source, said means cooperating, at the instant each contestant passes the finish line, to produce an electrical impulse individual to said contestant, and means for indicating the order of production of said impulses.

2. Apparatus for determining the order of arrival of race contestants at a finish line comprising means substantially defining an upright plane at the finish line, means carried by each contestant in the race, one of said means comprising a light source and the other a detector of light from said source, said means cooperating, at the instant each contestant passes the finish line, to produce an electrical impulse individual to said contestant, and means for recording the order of production of said impulses.

3. Apparatus for determining the order of arrival of race contestants at a finish line comprising means substantially defining an upright plane at the finish line, means carried by each contestant in the race, the means carried by each contestant cooperating photoelectrically with said plane defining means, at the instant each contestant passes the finish line, to produce an electrical impulse individual to said contestant, and means for indicating the order of production of said impulses.

4. Apparatus for determining the order of arrival of race contestants at a finish line comprising means substantially defining an upright plane at the finish line, means carried by each contestant in the race, the means carried by each contestant cooperating photoelectrically with said plane defining means, at the instant each contestant passes the finish line, to produce an electrical impulse individual to said contestant, and means for recording the order of production of said impulses.

5. Apparatus for determining the order of arrival of race contestants at a finish line comprising means substantially defining an upright plane at the finish line, means carried by each contestant in the race, the means carried by each contestant cooperating photoelectrically with said plane defining means, at the instant each contestant passes the finish line, to produce an electrical high frequency impulse having a frequency individual to said contestant, and means for indicating the order of production of said impulses.

6. Apparatus for determining the order of arrival of race contestants at a finish line comprising means substantially defining an upright plane at the finish line, means carried by each contestant in the race, the means carried by each contestant cooperating photoelectrically with said plane defining means, at the instant each contestant passes the finish line, to produce an electrical impulse individual to said contestant, a board comprising indicators of the finishing positions of the contestants, and means responsive to said impulses for operating said indicators.

7. Apparatus for determining the order of arrival of race contestants at a finish line comprising means substantially defining an upright plane at the finish line, means carried by each contestant in the race, the means carried by each contestant cooperating photoelectrically with said plane defining means, at the instant each contestant passes the finish line, to produce an electrical impulse individual to said contestant, and means for indicating the order of production of said impulses, said last means comprising elements corresponding to at least several possible positions of each contestant, and devices interconnecting said elements so that initially only the elements corresponding to the winning positions of the contestants may be affected by said impulses, and so that as soon as one of said elements corresponding to winning positions is affected, the remaining elements corresponding to winning positions are rendered incapable of being affected by subsequent impulses and the elements corresponding to second positions of the contestants are rendered capable of being affected by said impulses.

GEORGE MILLER.