

[54] SYSTEM FOR USE IN THE SUPERVISION
OF A MOTOR-BOAT RACE OR A SIMILAR
TIMED EVENT

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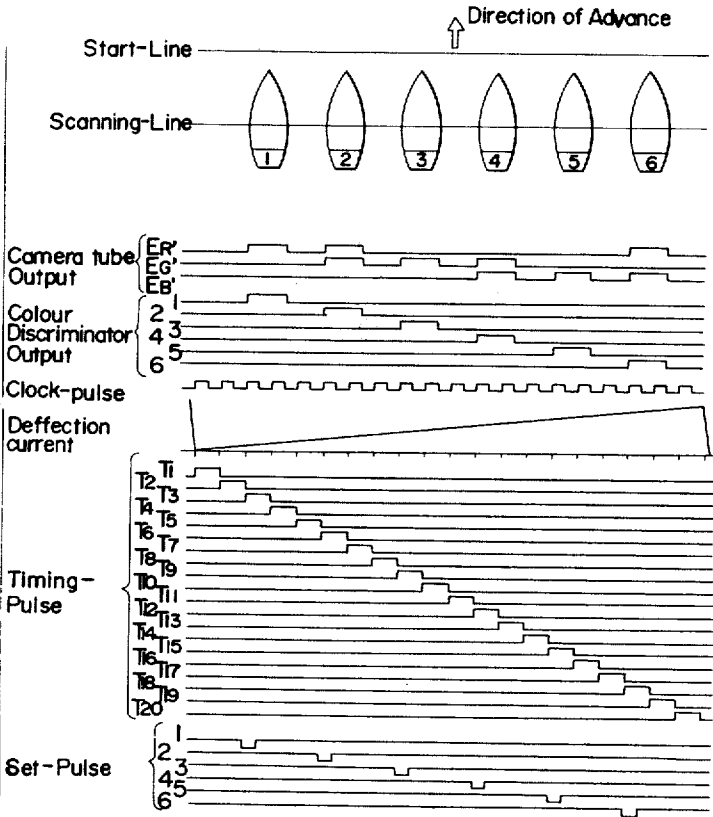
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178/DIG. 33, 5.4 ES, 5.4 R, DIG. 38, 6.7 R,
178/6.8; 340/323, 23, 43, 146.3 B, 146.3 K;
273/86 B, 86 R; 358/53, 50, 41, 52, 43, 81,
273/82, 75, 78

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[57] **ABSTRACT**
The present disclosure is directed to a motor-boat race supervision system wherein electrical output produced by camera tubes in response to motor-boats of different colours crossing a starting line or finishing line of a race is supplied to various combined, electrical elements in timed sequence and whereby the times relative to a starting signal that different motor-boats in a race cross the starting line or finishing line are made known instantaneously.

11 Claims, 16 Drawing Figures



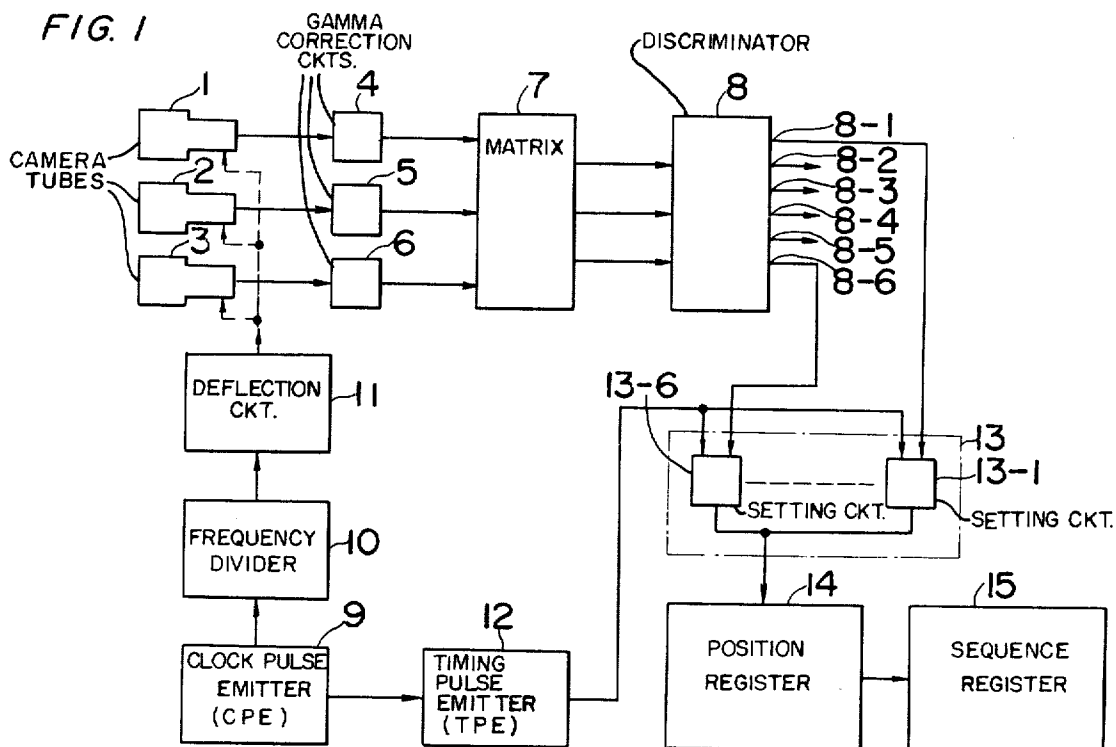


FIG. 4

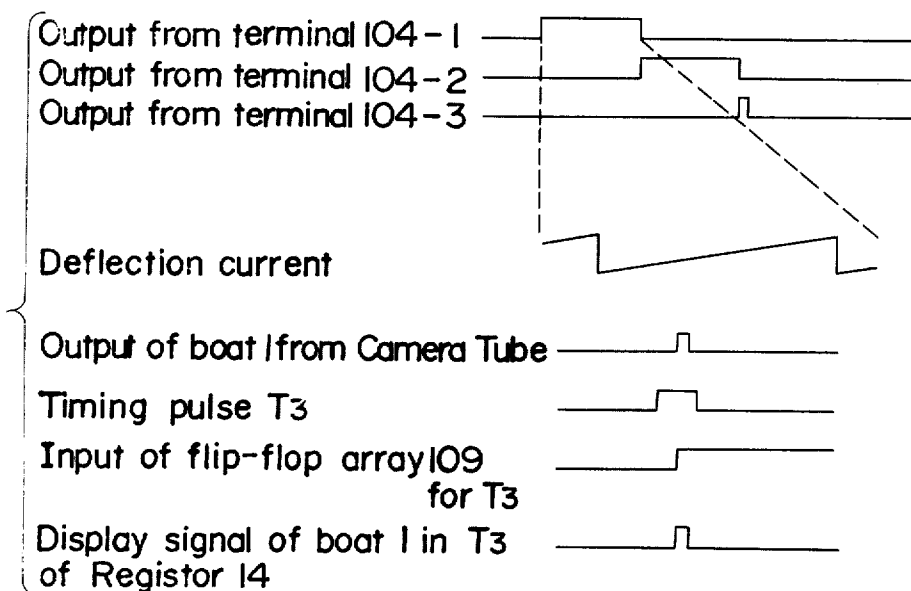


FIG. 2

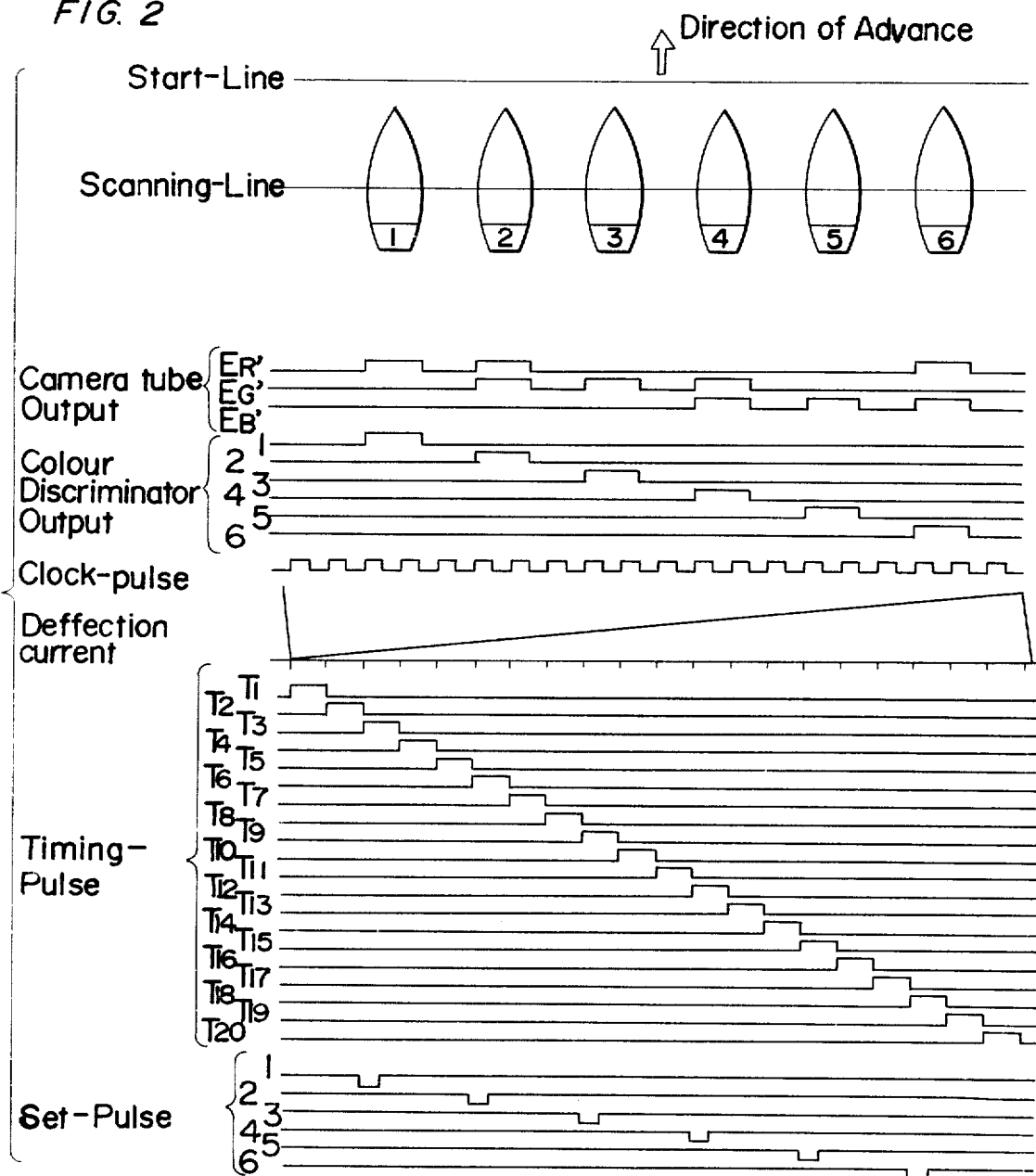


FIG. 3

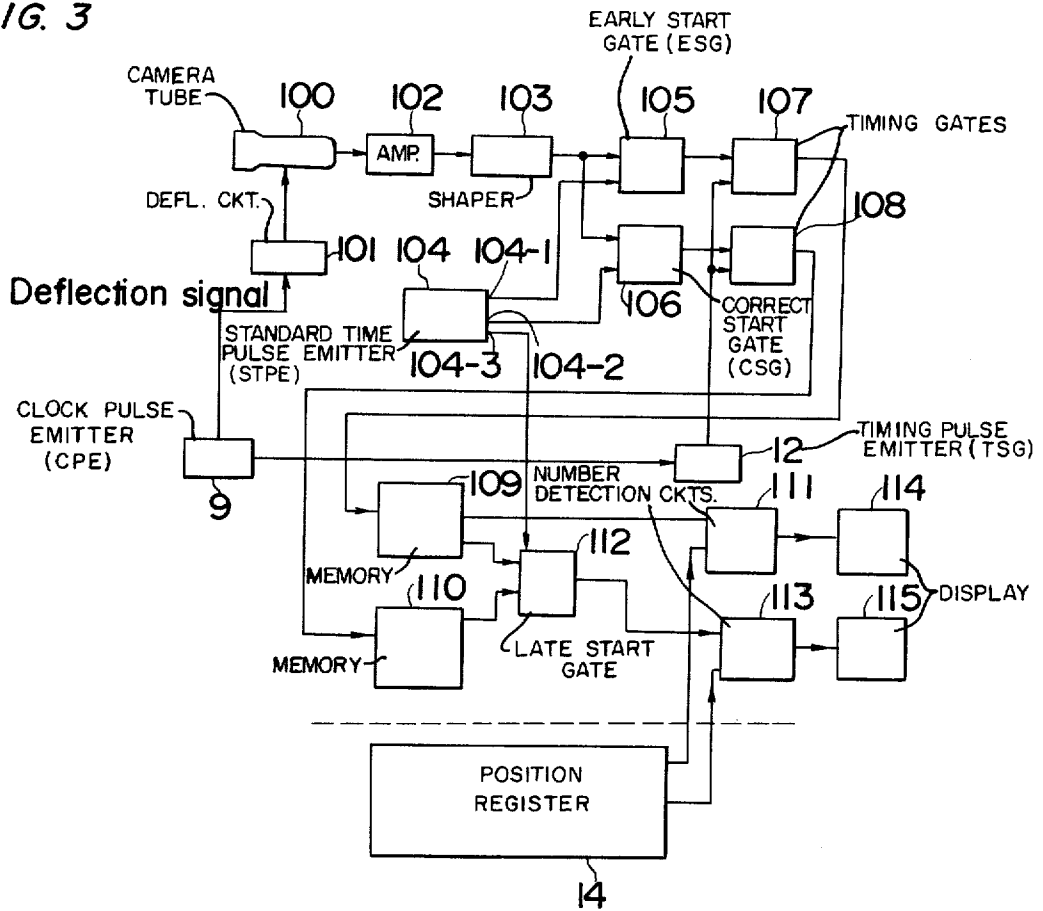
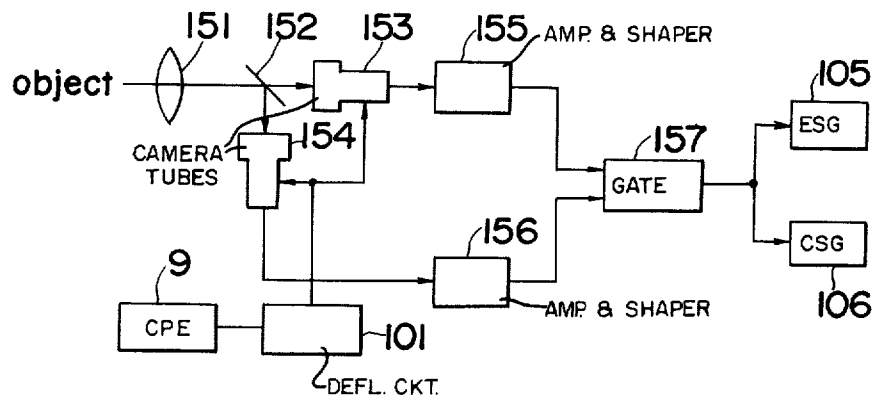


FIG. 5



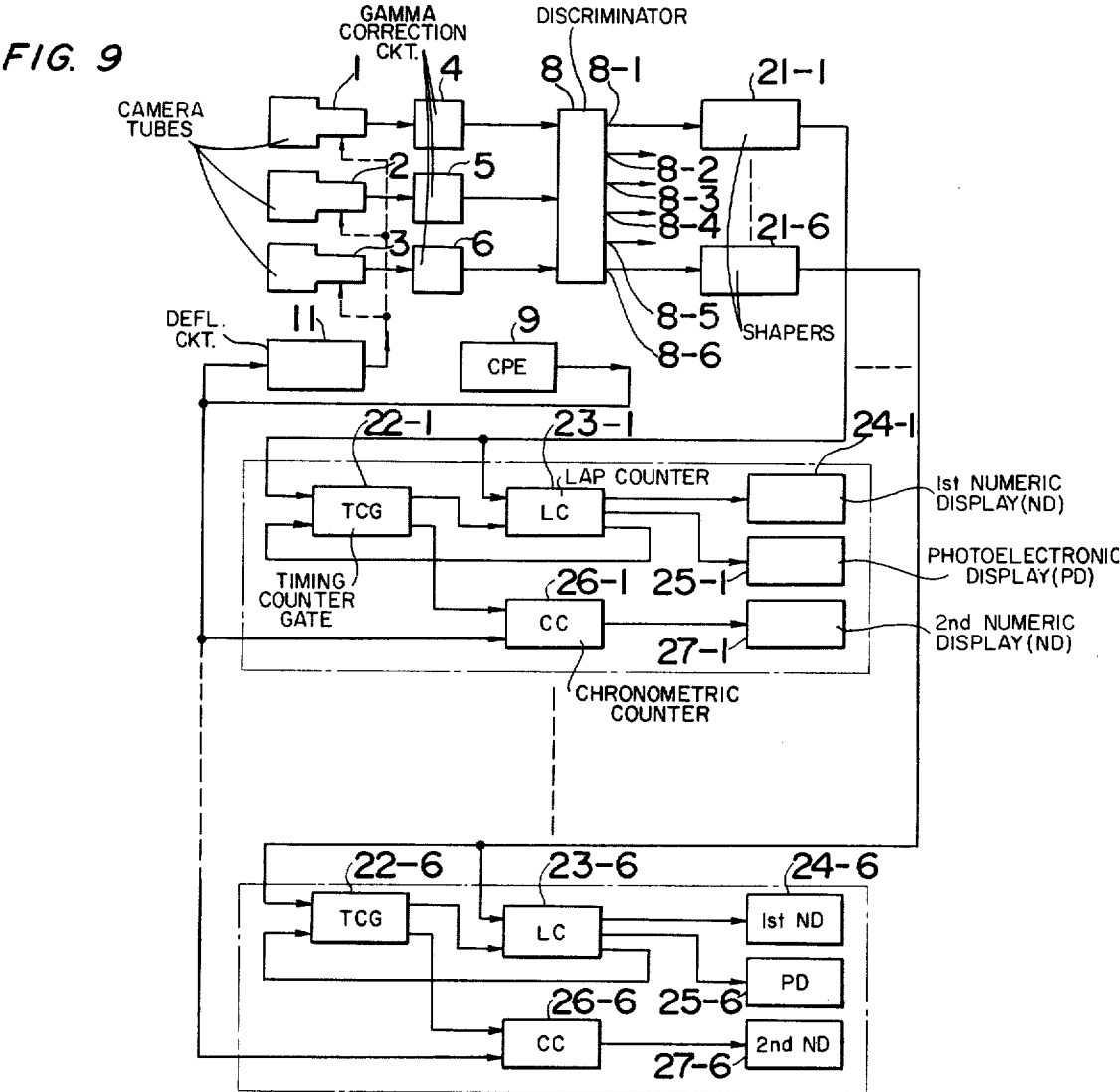


FIG. 11

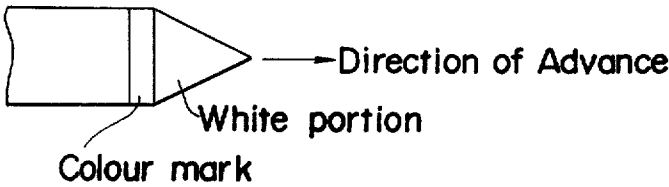


FIG. 8

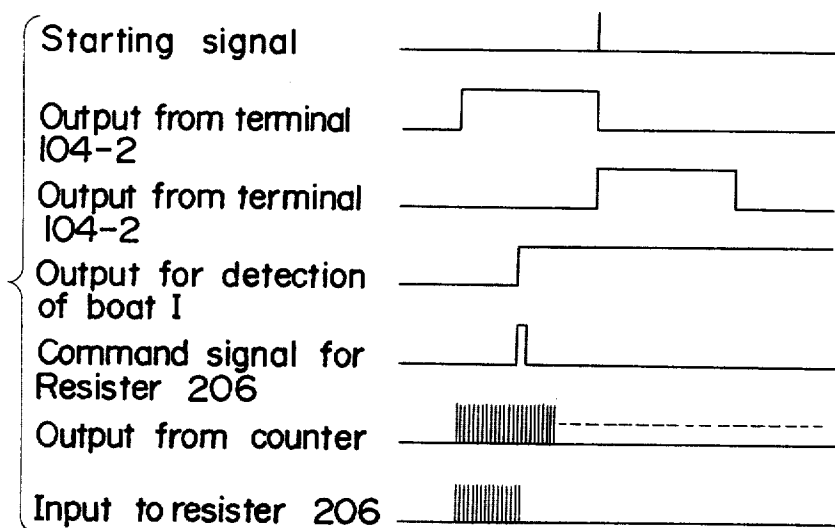


FIG. 10

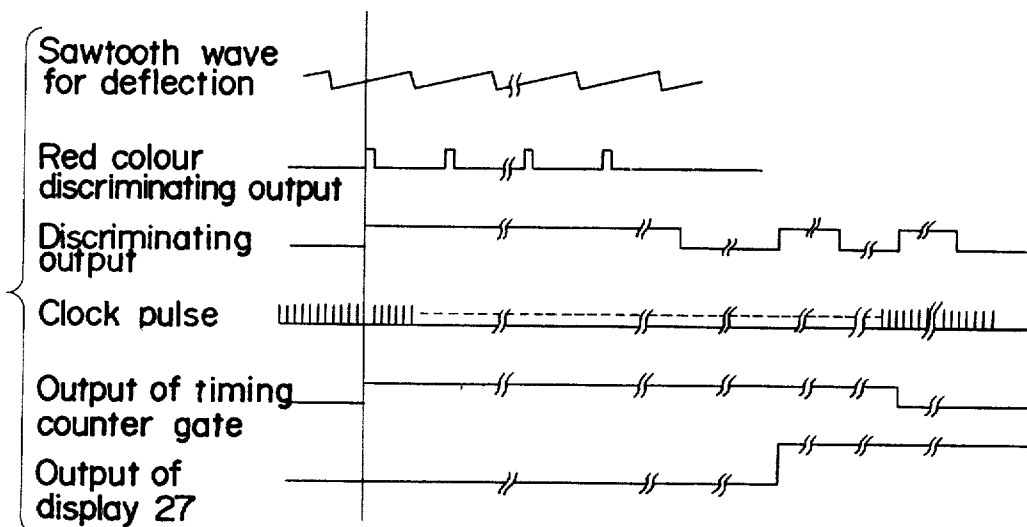


FIG. 12

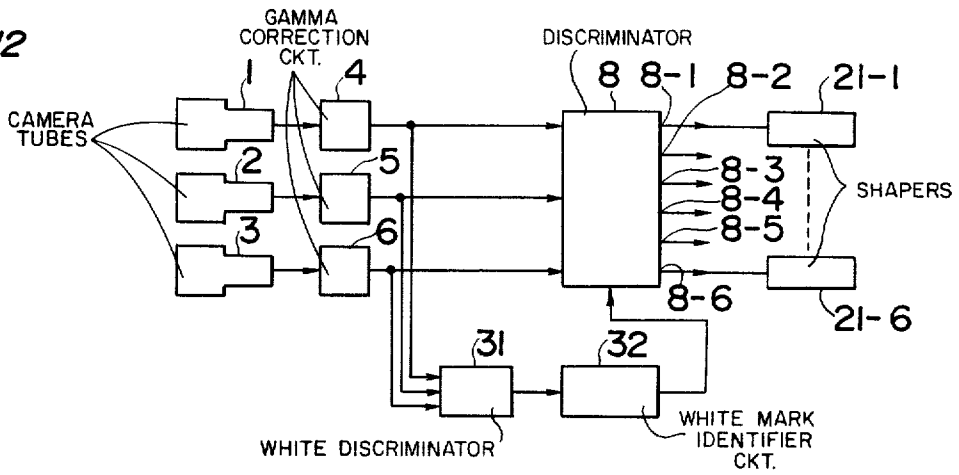


FIG. 13

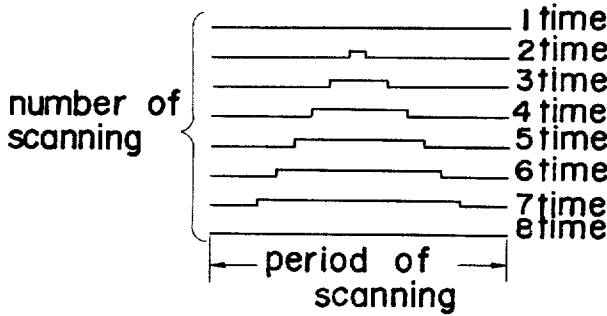


FIG. 14

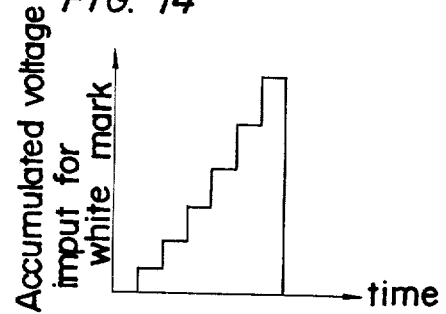


FIG. 16

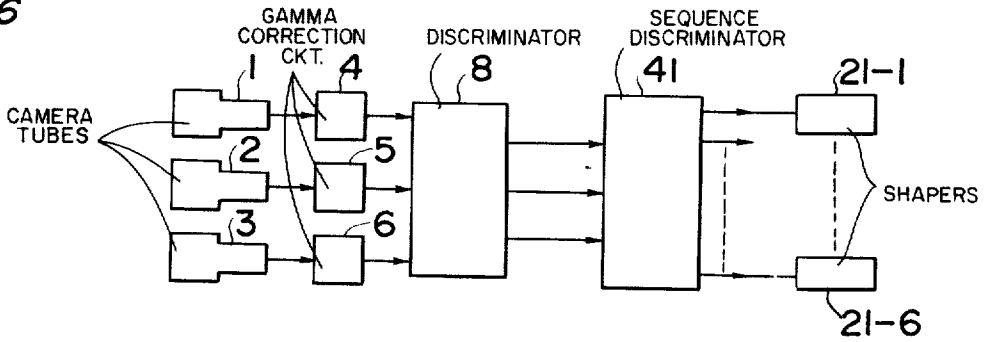


FIG. 15

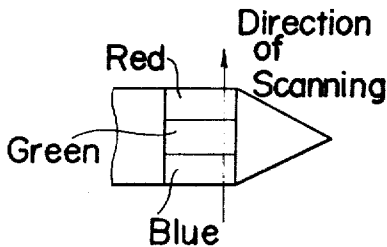
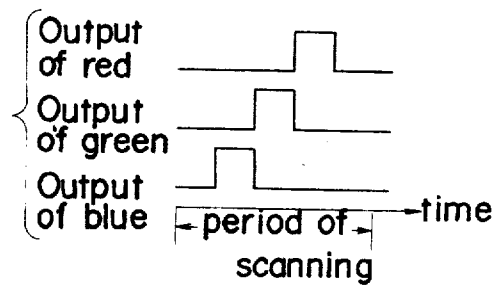


FIG. 17



SYSTEM FOR USE IN THE SUPERVISION OF A MOTOR-BOAT RACE OR A SIMILAR TIMED EVENT

The present invention relates to a system for use in the management or supervision of races or similar timed events and, more particularly, to a system whereby race officials and participants may have precise information for controlling the start and finish of a race such as a motor-boat race.

The present invention also pertains to a motor-boat race supervision system which can be effectively utilized in connection with the race management system.

In motor-boat races the start of a race is generally not from a stationary position but is what is known as a flying start. In a flying start, instead of lining up on a starting line and then beginning to move when a starting signal is given, motor-boats first assemble some distance behind the starting line and start to move towards the starting line a short time before the starting signal is given. The object of each competitor is to be travelling as quickly as possible and to be behind but as near as possible to the starting line at the moment the starting signal is given. One of the tasks of supervising or judging this type of race is that of ensuring that no motor-boats have crossed or are crossing the starting line before the starting signal is given.

Also, race regulations may require motor-boats to have crossed the starting line within a specified time after the start of a race. But since motor-boats are in rapid motion and close to the starting line at the start of the race it is extremely difficult to determine by direct observation which competitors should be disqualified for crossing the starting line prior to the start of a race, or which competitors should be notified of a slow start. The conventional method of judging the start of a motor-boat race has been to take a photograph of the starting line at the moment the starting signal is given and produce an enlargement of the photograph which is then examined by the judges. However, this conventional method has the disadvantages that time is required to develop the photograph, and more time is required to produce a suitably enlarged copy to determine whether the start of a race has been conducted properly or not until some time after the start of the race. Very often, especially in the case of short races, it is not possible to examine the photograph of the start of a race until the race is completed, which means the next race must be delayed until the results of the first race are known.

Judging the positions of boats relative to the finishing line at the end of a race presents similar problems and delays. Such delays accumulate from one race to another, and considerably hinder the work of managing a race meeting. Also, it is common practice for races covering a long distance to take the form of completion of a set number of laps of a circuit or track at a stadium or race-course, the advantage of such a procedure being, of course that it is possible to hold a race of any distance in a limited area. This procedure has the disadvantage, however, that, unlike races in which the start and finishing line are separate it is not possible to determine the winners of races merely by observing which participants in a race cross the finishing line first, since in circuit races the start and finishing line are usually the same, and all participants in a race cross the finishing line not once, but at many times as laps they are re-

quired to complete. To judge circuit races it is therefore necessary to count the number of laps each participant completes after the start of the race, and the first participant to complete the required number of laps is declared the winner. This has the obvious disadvantages that running such a race requires a large staff and that human error is possible. Also, even supposing that there are no errors by the officials in counting the laps each participant in a race completes, it is by no means easy for spectators of such a race to judge what the order of the participants is at any given moment, especially when one or more participants 'lap' others in which case the leading participants appear to be running behind the slower competitors.

It is accordingly an object of the present invention to provide an improved means for judging the start or finish of a object race.

It is a further object of the invention to provide an electrical means whereby the positions of objects relative to a starting line or finishing line at the start or finish of a race may be known instantaneously.

It is another object of the invention to provide an electrical means whereby it may be known instantaneously which objects in a race are to be disqualified for making an early start and which objects are to be notified of having made a late start.

It is another object to provide a object race judging means whereby information relative to the positions of objects at the beginning of a race is provided electrically, instantaneously and with improved precision.

It is a still further object of the invention to provide an electrical means whereby it may be known instantaneously which objects in a object race have made an early, correct, or late start, and also what amounts of time clear to or after a starting signal different object cross the starting line, and also the times taken by different objects to complete a race.

It is still another object of the invention to provide a object race judging means which requires less staff and which eliminates errors in counting the laps completed by different objects in a circuit race.

In accomplishing these and other objects there is provided according to the present invention a means wherein colour camera tubes scan a line over which motor-boats of different colours are to cross, and generate electrical signals in response to the primary colours present in the colours of motor-boats scanned. The camera tube signals are supplied to a discriminator means which generates coded signals which vary in accordance with the different combinations of primary colour signals received, and which therefore correspond to different colours of different motor-boats and serve to identify different motor-boats viewed by the camera tubes. A timing pulse means generates sequential trains of pulses in which each successive pulse is generated as each successive portion of the line to be crossed by motor-boats is scanned by the camera tubes, in each scanning period therefore, each pulse in each train corresponding to a different portion of the line scanned. The discriminator means coded signals and the timing pulses are supplied to a register which contains as many addresses as there are pulses in one timing pulse train and which records the number of a boat upon coincidence of a coded signal and a timing pulse, and the contents of the register are read out in the order of the register addressed.

In another embodiment of the invention there is provided another camera tube for scanning motor-boats crossing a starting line, a means for distinguishing output from said camera tube according to whether it is produced in response to motor-boats crossing a starting line prior to, within a set time after, or after a set time after a starting signal, and means for displaying numbers of motor-boats separately and distinguishing motor-boats according to whether they start a race too early, correctly, or late.

In another embodiment of the invention input to said video signal output distinguishing means only when there is simultaneous output from two camera tubes scanning respectively the starting line of a race and a line parallel thereto, whereby objects other than motor-boats on the starting line are not the source of video signals that could be misinterpreted as being caused by motor-boats.

In another embodiment of the invention there is provided a time counting means which counts time from a set time before to the completion of a race and which supplies inputs to display means simultaneously with motor-boat number input thereto, whereby the times motor-boats cross the starting line of a race prior to or after the starting signal of a race, and the times taken by motor-boats to complete a race may be known.

In a further embodiment of the invention, objects in a race are given identifying colours, a colour television camera constantly scans a line in a target area which is made the start/finish line of a race, and the colour television camera detects each time each object crosses the finishing (start/finish) line, emits a detection pulse to a counter means each time each object crosses the finishing line, and the counter means keeps accumulative totals for the detection pulses received relating to each individual object, whereby the number of laps completed by each object by any given time from the start of a race may be known.

Also in the system of the invention, in addition to the above-mentioned detection and lap-counting means, there is provided a chronometering means which is started simultaneously with a race, whereby it may be known how long it has taken each object in the race to complete the number of laps as made known by the detection and lap counting means.

Other features and objects of the invention will be become apparent from the full description below of a non-limiting embodiment thereof, taken in conjunction with the attached drawings, in which;

FIG. 1 is a block diagram of a 1st embodiment of the invention,

FIG. 2 shows wave-forms obtained in elements of the 1st embodiment,

FIG. 3 is a block diagram of a 2nd embodiment of the invention,

FIG. 4 shows wave-form obtained in elements of the 2nd embodiment,

FIG. 5 is a block diagram of a 3rd embodiment of the invention,

FIG. 6 shows wave-forms obtained in elements of the 3rd embodiment,

FIG. 7 is a block diagram of a 4th embodiment of the invention,

FIG. 8 shows wave-forms obtained in elements of the 4th embodiment,

FIG. 9 is a block diagram of a 5th embodiment of the invention,

FIG. 10 shows wave-forms as obtained in elements shown in FIG. 9,

FIG. 11 shows part of an object scanned by a colour television camera,

FIG. 12 is a partial block diagram of a 6th embodiment of the invention,

FIGS. 13, 14 show wave-forms as obtained in elements shown in FIG. 12,

FIG. 15 shows part of an object scanned by a colour television camera,

FIG. 16 is a partial block diagram of a 7th embodiment of the invention, and

FIG. 17 shows wave-forms as obtained in elements shown in FIG. 16.

Before the description of the present invention proceeds, it is to be noted that like parts are designated by the like reference numerals throughout the several views of the accompanying drawings. It is further to be noted that, for the sake of brevity, the description of the present inventions will be hereinafter made as an example in conjunction with a motor-boat race in which six motor-boats participate, the six motor-boats being distinguished by the colours red, yellow, green, cyan, blue, and magenta.

According to one embodiment of the invention, which is shown in block diagram form in FIG. 1, objects to be photographed are scanned simultaneously by a camera tube assembly C composed of three camera tubes 1, 2, 3. Between the camera tubes 1, 2, 3 and the objects to be photographed there is provided an optical system for breaking down the optical images of objects scanned into the three primary colours red, green and blue. This optical system is suitably composed of an assembly of mirrors, half-mirrors blue reflection dichroic mirrors, red reflection dichroic mirrors and similar elements. The camera tube 1 produces an electrical signal output ER in response to red portions in a scanned scene. The camera tube 2 produces an electrical signal output EG in response to green portions in a scanned scene. The camera tube 3 produces an electrical signal output EB in response to blue portions in a scene scanned. The camera tubes may be, for example, image orthicons or vidicons. According to the invention scanning by the camera tubes 1, 2, 3 is repetitive from one end of a single line to the other, in other words scanning is uni-linear, and output from the camera tubes, 1, 2, and 3 is produced in response to photo-images of objects on this line only. The line scanned by the camera tubes, 1, 2, 3 is the starting line of a race or a line parallel thereto and at a distance of about several centimeters therefrom. Output from the camera tube assembly C at a particular moment depends on the objects on the race start line at that moment and the individual outputs of the camera tubes 1, 2, 3 at that moment depend on the proportion of primary colours present in the objects on the starting line. In other words outputs from the camera tubes 1, 2, 3 at the start of a motor-boat race depend on the colours of the motor-boats crossing the start-line. To maintain focus by the camera tubes 1, 2, 3 over the whole of the scanning line, a pulse of sawtooth wave form is applied to the deflection coils of the camera tubes 1, 2, 3. In this embodiment the period of the sawtooth wave applied to the camera tube deflection coils is 63.5 micro seconds, the wave is supplied from a deflection circuit 11. Input to the deflection circuit 11 is from a frequency divider 10. Timing input to the frequency divider 10 is from a clock pulse emitter

9. In other words, frequency output of the frequency divider 10 is a fraction of the emitter 9 clock pulse frequency and this output is supplied to the deflection circuit 11, which therefore supplied sawtooth waves to the camera tube deflection coils at a frequency that is a fraction of the emitter 9 clock pulse frequency.

After passing through gamma correction circuits 4, 5, 6 the output of electrical signals produced by the camera tubes 1, 2, 3 in response to the proportions of the primary colours in the objects (that is motor-boats viewed is supplied as input to a matrix 7 and thence to a colour discriminator circuit 8. For each portion of a scene viewed the voltage of the camera tube 1 output depends on the amount of red in the scene, and similarly the voltages of the outputs of the camera tubes 2 and 3 depends on the amount of green and blue present. Therefore the colour of a motor-boat viewed at a particular instant can be determined by the matrix 7 and colour discriminator circuit 8 since the proportions of the voltages of the chrominance signals from the camera tubes 1, 2, 3 vary in accordance with the colour of the particular motor-boat being viewed; for example, if the motor-boat is red, ER forms 100% of the output. In this embodiment provision is made for thus distinguishing boats of six different colours, which are red, yellow, green, cyan, blue and magenta. It is to be understood, however, that exactly the same principles apply to distinguishing colours of boats other than the ones cited above.

The colour discriminator circuit 8 has six output terminals 8-1 through 8-6. When chrominance signal input to the colour discriminator circuit 8 is that produced by the camera tube assembly C in response to a red motor-boat being viewed the colour discriminator circuit 8 produces an output at its terminal 8-1. Similarly an output signal is produced at the colour discriminator output terminals 8-2, 8-3, 8-4, 8-5, or 8-6, respectively, when a yellow, green, cyan, blue or magenta boat is being viewed by the camera tube assembly C.

Output from the colour discriminator circuit 8 is supplied to setting circuits 13-1 through 13-6 which provide output to set a position register 14 (described below) and each of which has two input terminals. Output from the colour discriminator terminal 8-1 is supplied to one terminal of the setting circuit 13-1, and similarly setting circuits 13-2, 13-3, 13-4, 13-5, 13-6 receive input at one input terminal from the colour discriminator output terminals 8-2, 8-3, 8-4, 8-5, 8-6, respectively. Therefore, at one input terminal of each setting circuit 13-1 through 13-6 there is an input only when a particular motor-boat is viewed by the camera tube assembly C. For example, one input terminal of the setting circuit 13-1 receives an input only when the red motor-boat is viewed by the camera tube assembly C. The other input terminals of the setting circuits 13-1 through 13-6 constantly receive an input from a timing pulse emitter 12. The timing pulse emitter 12 receives input from the clock pulse emitter 9. The timing pulse emitter 12 always produces a steady output of pulses T of a duration that is 1/20 that of the sawtooth wave supplied to the deflection coils of the camera tubes 1, 2, 3 by the deflection circuit 11 and at a frequency that is 20 times that of the sawtooth waves. The duration of one train of pulse emitter 12 output pulses T1-T20 is therefore the same as the duration of one sawtooth wave applied to the deflection coils of the camera tubes

1, 2, 3, that is the same as the time necessary to complete one scanning line by the camera tube assembly C. Therefore each timing pulse T supplied to the setting circuits 13-1 through 13-6 is supplied when a particular portion of the target line is being scanned by the camera tube assembly C. Timing pulse T1 is supplied when the first portion of the target line is scanned and timing pulse T2 is supplied when the next portion of the target line is scanned, and succeeding timing pulses T3-T20 are supplied when succeeding portions, to the end, of the target line are scanned. In other words the timing pulses T1-T20 serve to identify which portion of the target line is being scanned by the camera tube assembly C and the target line is divided into twenty portions. Supposing that six boats I-VI, which are respectively red, yellow, green, cyan, blue and magenta, advance together at equal intervals toward a starting line and that scanning of the start line by the camera tube assembly C is from left to right as seen from the direction of advance of the boats, then as the boats cross at the same time the starting line the camera tube assembly C scans the boats in the order red, yellow, green, cyan, blue and magenta boat (i.e. I-VI), and the red boat I is scanned during the period in which the timing pulse emitter 12 emits timing pulses T3, the yellow boat II is scanned during timing pulse T6, the green III boat is scanned during timing pulse T9, the cyan IV boat is scanned during timing pulse T12, the blue boat V is scanned during timing pulse T15, and the magenta boat VI is scanned during timing pulse T18.

Each setting circuit 13 produces output only the first time it receives input at both input terminals and thereafter output is inhibited. For example, if setting circuit 13-2 receives an input from the colour discriminator output terminal 8-2 during timing pulses T4, T5 and T6, the setting circuit 13-2 receives an input at both input terminals during timing pulses T4, T5 and T6, but the setting circuits 13-2 supplies input to the register 14 only once, at timing pulse T4. Therefore in one operation of viewing the start of one race the setting circuits 13-1 through 13-6 cause only one setting each in the register 14. Also when all the circuits 13-1 through 13-6 have provided an output, that is when all the boats I-VI have crossed the starting line and the numbers of all the boats I-VI have been recorded in the register 14, there is a signal given by a means provided in association with the setting circuits 13 to signify the end of an operation, and the action of all the circuits 13 is suspended.

It is not essential for the duration of the pulses supplied by the timing pulse emitter 12 to the setting circuits 13-1 through 13-6 to be 1/20 that of the camera tube deflection coil sawtooth waves, but can be made any fraction thereof. For example, the duration of the emitter 12 pulses can be 1/5 that of the deflection circuit 11 sawtooth waves. This would correspond to dividing the target line scanned by the camera tube assembly C into five portions. But in all cases, the selection of timing pulse T frequency and duration must be such that no more than one boat can be scanned during one timing pulse T1.

The purpose of the register 14 is to record whether or not signals are emitted by the camera tubes 1, 2, 3 in the above-described time intervals during T1-T20. That is the register 14 records whether or not the red boat 1 crosses the starting line during timing pulses T1-T20, and so on. The register 14 comprises an en-

coder and a matrix of flip-flops. The matrix consists of 60 flip-flop circuits arranged in 20 columns, from right to left, of three flip-flops each. Change-over input to each flip-flop is through an AND circuit with two input terminals A and B. In other words each flip-flop is caused to change state only when there are inputs at both the input terminals of its preceding AND circuit. Each column of the flip-flop matrix of the register 14 is for recording the number of a boat in binary notation.

The flip-flops of the 1st, 2nd, and 3rd rows of the matrix are for registering 1 or 0 for the values 2^0 , 2^1 , and 2^2 , respectively. Prior to the beginning of an operation (i.e. before the start of a race) all the flip-flop circuits are cleared to 0. When operation starts succeeding timing pulses T are applied to the A terminals of AND circuits of succeeding matrix column, that is, the A terminals of the AND circuits preceding the three flip-flops in the 1st column receive an input of timing pulse T1, the A terminals of the AND circuits preceding the flip-flops of the 2nd column receive an input of timing pulse T2, and so on. The encoder of the register 14 receives input from the setting circuits 13 and supplies binary coding signals to the flip-flop matrix. To obtain the recording of a 2^0 value, the encoder supplies an input to the B input terminals of all the AND circuits preceding the flip-flops in the 1st row of the matrix. Similarly, to obtain the recording of a 2^1 or 2^2 value the encoder supplies input signals to the B input terminals of the AND circuits in the 2nd or 3rd rows, respectively. Output from the encoder depends on which setting circuit 13 supplies input thereto. As described above during the timing pulse T3 the camera tube assembly C scans the portion of the starting line over which the red boat 1 crosses, and scans the starting line portions crossed by the yellow boat II, green boat III, cyan boat IV, blue boat V, and magenta boat VI during the timing pulses T6, T9, T12, T15, and T18, respectively. Therefore when, for example, the green boat III crosses the starting line at the timing pulse T9, there is an input from the camera tube assembly C through the matrix 7 and colour discriminator circuit 8 to the setting circuit 13-3, and the setting circuit 13-3 supplies input to the B terminals of all the AND circuits. Also at timing pulse T9 there is input to the A terminals of the AND circuits in the 9th column of the matrix. Therefore, in the register 14 matrix, the only AND circuits having inputs at both terminals are the AND circuits of the 2nd and 3rd row of the 9th column, and 3 in binary code is recorded in the 9th column of the matrix. In this manner the binary coded numbers 1, 2, 3, 4, 5, 6 in correspondence to boat numbers I-VI can be recorded in the register 14 matrix columns 3, 6, 9, 12, 15, 18, respectively, and the different columns of the register 14 matrix serves as addresses for different boats. As described above, the contents of the register 14 are cleared to 0 prior to an operation of scanning the start of a race, and, since the setting circuits 13-1 through 13-6 provide input to the register 14 only one time each in one operation, once set, addresses in the register 14 cannot be changed until the whole register is cleared to 0 again prior to the next race. A suitable means is provided in association with the register 14 to provide read-out of the contents thereof.

The read-out means provides information concerning the positions of the boats I-VI relative to a starting line at the beginning of a race. That is, the read-out means

makes it possible to know which boats I-VI cross the starting line at the beginning of the race. When it is also required to know the order of the boats I-VI at the beginning of a race, the contents of the register 14 are shifted sequentially to the right and supplied to a sequence register 15. The sequence register 15 comprises six series-connected flip-flops corresponding to the 1st row of the position register 14 flip-flop matrix, six series-connected flip-flops corresponding to the 2nd row of the register 14 matrix, and six flip-flops corresponding to the 3rd row of the register 14 matrix. The flip-flops of the sequence register 15 thus form a matrix of six columns of three flip-flops each. As in the position register 14, the 1st, 2nd and 3rd rows of the flip-flop matrix in the sequence register 15 are for recording 1 or 0 for the values 2^0 , 2^1 , and 2^2 , respectively. Successive values of numbers set in the position register 14 are shifted to the right, in the order in which they occur, to be recorded in successive column, from right to left, of the sequence register 15. Thus at the end of one operation, the contents of the sequence register 15 represent the order in which the numbers of the boats I-VI were recorded in the position register 14. If it is not required to know the sequence in which boat numbers are recorded in the registers 14, it is not essential for the line scanned by the colour camera assembly C to be parallel to the starting line of a race.

A description of the operation of the above-described equipment is given below. Supposing first that a red boat I, a yellow boat II, a green boat III, a cyan boat IV, a blue boat V, and magenta boat VI are aligned from left to right the order I-VI and that they advance simultaneously from behind a starting line and cross the starting line together. In this case the boats I-VI cross different portions of the starting line, that is the red boat I crosses the extreme left-hand portion of the starting line, the yellow boat II crosses the portion next to the extreme left-hand portion, and so on, the magenta boat VI crossing the extreme right-hand portion of the starting line. The camera tubes 1-3 are set up to scan a line that is parallel to the starting line and that is crossed by the boats I-VI before the starting line. Scanning by the camera tube assembly C is controlled by current supplied by the deflection circuit 11. Input to the deflection circuit 11 depends on output from the frequency divider 10, which is controlled by the clock pulse emitter 9, which also controls the timing pulse emitter 12. Successive timing pulses T1-T20 are supplied to one terminal of each of the setting circuits 13-1 through 13-6, and also to the A terminals of the AND circuits of flip-flop in successive columns of the register 14 flip-flop matrix. Timing pulses T3, T6, . . . T18 are supplied in the times that the camera tube assembly C scans the portions of the line parallel to the starting line that are crossed by the red boat I, . . . magenta boat VI. Scanning of the line parallel to the starting line by the camera tubes 1-3 continues from a set time before to a set time after the signal for starting the race and is from left to right as seen in the direction of advance of the boats I-VI. The boats I-VI are therefore scanned in the order I, II, III, IV, V, VI. Output from the camera tube assembly C is therefore, successively, 100% ER from the camera tube 1, 50% ER and 50% EG from the camera tubes 1 and 2 respectively, 100% EG from the camera tube 2, 50% EB from the camera tubes 2 and 3 respectively, 100% EB from the camera tube 3, 50% EB and 50% ER from the camera tubes 3 and 1 respec-

tively. These successive outputs are supplied through the matrix 7 to the colour discriminator 8; and in response the colour discriminator 8 produces successive outputs at the terminals 8-1 through 8-6. These successive outputs are supplied to successive setting circuits 13-1 through 13-6. Therefore each setting circuit 13-1 through 13-6 in turn receives an input at both input terminals, a timing pulse input at one terminal and input from the colour discriminator 8 at the other terminal. Each setting circuit 13-1 through 13-6 in turn supplies an input to the register 14 and successive boat number I-VI are recorded in successive addresses of the register 14. Read-out of the contents of the register 14 now gives the information that at the time of the signal for starting the race the boats I-VI were crossing a line behind the starting line and therefore all made a correct start. Recording of the numbers of boats crossing a finishing line can of course be obtained in a similar manner. When boats cross the starting line at different times, the boat numbers I-VI are not necessarily recorded in the order, I, II, III, IV, V, VI in the register 14. In this case, the order in which the boats I-VI cross the starting line is made known if, as well as read-out of the contents of the register 14, the numbers recorded in the register 14 are shifted sequentially to the right and into the sequence register 15. Twenty shift pulses complete the transfer of the contents of register 14 to the sequence register 15, and the contents of the sequence register 15 from right to left give the order in which boats crossed the starting line.

According to another embodiment of the invention, there are also provided in association with the above-described equipment means for separate indication of numbers of boats making an early or late start. These means are shown in block diagram form in FIG. 3, and wave forms obtained therein are shown in FIG. 4. Referring to FIG. 3, there is shown a camera tube 100. The camera tube 100 scans the same line as, and at the same scanning frequency as, the camera tubes 1, 2, 3. Sweep control in the camera tube 100 is effected by a deflection circuit 101, which is itself controlled in the same manner as the deflection circuit 11. Output of the camera tube 100 is supplied to a video amplifier 102. The output produced by the video amplifier 102 in response to input from the camera tube 100 is supplied to a shaping circuit 103. The shaping circuit 103 converts input from the video amplifier 102 to rectangular pulse output. Output from the shaping circuit 103 is supplied to one input terminal of an early start detection gate 105 and to one input terminal of a correct start detection gate 106. The early start detection gate 105 and the correct start detection gate 106 also receive input from a standard time pulse emitter 104 and each detection gate 105, 106 has two input terminals and produces an output only when there is a simultaneous input at both input terminals. The standard time pulse emitter 104 has three output terminals, 104-1, 104-2, 104-3. Logic 1 outputs are produced from the terminals 104-1, 104-2, and 104-3 respectively prior to, at and for a set time after, and after a set time after the starting signal of a race. Logic 1 output from the pulse emitter terminal 104-1 is to permit detection of boats which make an early start and is supplied to the other input terminal (i.e. the input terminal that does not receive input from the shaping circuit 103) of the early start detection gate 105. Logic 1 output from the pulse emitter terminal 104-2 is to permit detection of boats

which make a correct start and is supplied to the other input terminal of the correct start detection gate 106. Logic 1 output from the pulse emitter terminal 104-3 is to permit detection of boats which make a late start and is supplied to a late start detection gate 112.

The early start detection gate 105 produces an output when it receives input at both input terminals simultaneously from the shaping circuit 103 and the standard time pulse emitter terminal 104-1. Output from the early start detection gate 105 provided input to one terminal of each of twenty gates 107-1 through 107-20 in a timing gate 107. Each timing gate 107-1 through 107-20 has two input terminals, and the other input terminal of each gate in turn receives an input of successive timing pulses T1-T20, which are the same timing pulses as those supplied to the setting circuits 13 and the position register 14; that is one terminal of timing gate 107-1 receives an input of timing pulse T1, timing gate 107-2 receives an input of timing pulse T2, and so on. Output from the timing gate network 107 provides setting input to a memory flip-flop array 109. The memory flip-flop array 109 consists of 20 flip-flops 109-1 through 109-20, which are for the purpose of recording the number of boats that make an early start. Each timing gate 107-1 through 107-20 produces an output only when it receives an input at both its input terminals simultaneously, and output from each succeeding timing gate 107 is supplied to each succeeding memory flip-flop 109; that is, output from timing gate 107-1 is supplied as setting input to memory flip-flop 109-1, output from timing gate 107-2 is supplied as setting input to memory flip-flop 109-2, and so on. There is also provided a boat number detection circuit 111 which is for the purpose of detecting the numbers of motor-boats that start too early, and which receives input from the position register 14 and from the memory flip-flop array 109. At succeeding timing pulses T1-T20 the boat number detection circuit 111 compares the states of successive memory flip-flops 109-1 through 109-20 with the states of the flip-flops in successive columns of the position register 14 flip-flop matrix; that is, at timing pulses T1 the boat number detection circuit 111 compares the state of memory flip-flop 109-1 with the state of the 1st flip-flop column of the register 14 matrix, at timing pulse T2 the detection circuit 111 compares the state of memory flip-flop 109-2 with the state of the 2nd flip-flop column of the register 14 matrix, and so on. When there is a coincidence of input, that is, when corresponding flip-flops in both the memory flip-flop array 109 and the register 14 matrix are set at the same time, the boat number detection circuit 111 produces an output which is supplied to a visual display means 114 to produce an identifying number. For example, if at timing pulse T6 the flip-flops of the 6th column of the register 14 matrix are set to register a binary coded 2 and memory flip-flop 109-6 also is set, the boat number detection circuit 111 supplies an input to cause the visual display means to display the number 2, thus giving the information that the boat II has started too early.

The correct start detection gate 106 produces an output when it receives input at both input terminals simultaneously from the shaping circuit 103 and the standard time pulse emitter terminal 104-2. Output from the correct start detection gate 106 provides input to one terminal of each of twenty gates 108-1 through 108-20 in a timing gate 108. Each timing gate 108-1

through 108-20 has two input terminals, and the other input terminal of each gate in turn receives an input of successive timing pulses T1-T20, which are the same timing pulses as those supplied to the setting circuits 13 and the position register 14; that is one terminal of timing gate 108-1 receives an input of timing pulse T1, timing gate 108-2 receives an input of timing pulse T2, and so on. Output from the timing gate network 108 provides setting input to a memory flip-flop array 110. The memory flip-flop array 110 consists of twenty flip-flops 110-1 through 110-20, which are for the purpose of recording the numbers of boats that make a correct start. Each timing gate 108-1 through 108-20 produces an output only when it receives an input at both its input terminals simultaneously, and output from each succeeding timing gate 108 is supplied to each succeeding memory flip-flop 110; that is, output from timing gate 108-1 is supplied as setting input to memory flip-flop 110-1, output from timing gate 108-1 is supplied as setting input to memory flip-flop 110-2, and so on.

The state of each successive memory flip-flop 109-1 through 109-20 and of each successive memory flip-flop 110-1 through 110-20 is detected at each successive timing pulse T1-T20 by the above-mentioned late start detection gate 112. The late start detection circuit 112 generates a pulse D at moments when neither of two corresponding memory flip-flops in the flip-flop arrays 109, 110 is set. For example, the late start detection circuit generates a pulse D if at timing pulse T12 neither memory flip-flop 109-12 nor memory flip-flop 110-12 is set. The late start detection gate 112 also compares the states of successive columns in the register 14 flip-flop matrix with those of the flip-flop arrays 109, 110, and, as stated earlier, receives input from the standard time pulse emitter terminal 104-3 after a set time after the start of a race has elapsed. When there is a coincidence of input from terminal 104-3 of the standard time pulse emitter 104, generated pulse D, and a binary coded number set in a corresponding column of the register 14 matrix, the late start detection gate 112 supplies an input to a visual display means 115 causing the relevant boat number to be displayed through a circuit 113.

Below is given a description of the operation of the 2nd embodiment of the invention.

It is supposed that, in a race between six motor-boats I-VI distinguished by different colours, boats II, IV, V and VI make a correct start, boat I starts too early, and boat III start late. In other words all the motorboats I-VI cross the starting line and the boat numbers I-VI are recored in the register 14 addressed I-VI (for example, if boats I, II, III, IV, V, VI respectively are first viewed by the camera tube assembly C at timing pulses T3, T6, T9, T12, T15, T18, a binary coded 1, 2, 3, 4, 5, 6 is recorded in column 3, 6, 9, 12, 15, 18, respectively, of the register 14 matrix), but boat I acrosses the starting line before the starting signal, boats II, IV, V, VI cross the starting line on or within a specified time after the starting signal, and boat III crosses the starting line later than the specified time after the starting signal. When boat I crosses the starting line the camera tube 100 produces, in response, an output which is supplied through the video amplifier to the detection gates 105, 106. But the motor boat I is viewed by the camera tube 100 at a time when the standard time pulse emitter 104 is producing output at its terminal 104-1 only, and therefore only detection gate 105 has input at both its

input terminals, and only detection gate 105 produces an output. This output acts through gate 107, memory flip-flop array 109, and detection circuit 111 to produce a display of the number 1 by an early start visual display means as described above; memory flip-flop 109-3 and the third column of register 14 are now set. Boats II, IV, V, VI cross the starting line when the standard time pulse emitter 104 is producing output at its 104-2 terminal, and therefore although camera tube 100 output is supplied to both detection gates 105, 106, only detection gate 106 has input at both input terminals. The detection gate 106 produces output which is passed through timing gate 107 to cause setting of corresponding flip-flops in the flip-flop array 109; the flip-flop 109-1, 109-2, 109-4, 109-5, 109-6 and the register 14 matrix columns 3, 6, 12, 15, 18 are now set. The motor-boat III crosses the starting line when the standard time pulse emitter is producing output at its terminal 104-3 only. At this time neither detection gate 105 nor detection gate 106 receives input at two terminals and so camera tube 100 output can have no effect in setting flip-flops in the array 109 or 110. When boat III crosses the starting line therefore, column 9 of the register 14 matrix is set, neither memory flip-flop 109-9 nor memory flip-flop 110-9 is set and so a pulse D is produced at the detection gate 112, and also there is an input to the detection gate 112 from the standard time pulse emitter terminal 104-3, and the detection gate 112 supplies an input to the late start visual display means to cause the number 3 to be displayed.

In a 3rd embodiment of the invention there are also provided in association with the above-described equipment means for ensuring that objects other than motor-boats on the starting line are not the source of video signals that could be misinterpreted as representing a motor-boat. These means are shown in block diagram form in FIG. 5, and wave forms obtained therein are shown in FIG. 6. Referring to FIG. 5, there is shown a half mirror 152 which is positioned between an object lens 151 and two camera tubes 153, 154. The object lens 151 directs image of objects to be viewed to the half mirror 152. Object images are directed through the half mirror 152 to the camera tube 153 and reflected from the half mirror 152 to the camera tube 154. Scanning by both the camera tubes 153, 154 is from left to right as seen in the direction of advance of motor-boats and is controlled and synchronized with that of the camera tube assembly C by current from the deflection circuit 101. The camera tube 153 scans a starting line of a race, and the camera tube 154 scans a line that is parallel to and about 30 cm behind the starting line. Output from the camera tube 153 is supplied to a video amplifier and wave shaping network 155. Output from the camera tube 154 is supplied to a video amplifier and wave shaping network 156. Output from the video amplifier and wave shaping network 155 is supplied to one input terminal of an AND gate 157, and output from the video amplifier and wave shaping network 156 is supplied to the other input terminal of the AND gate 157. Output from the AND gate 157 provides input to one terminal of the early or correct start detection gate 105 or 106, described in reference to the 2nd embodiment of the invention and shown in FIG. 3. The AND gate 157 produces an output only when it receives simultaneous input at both input terminals.

Below is given a description of the operation of the above-described means.

If, as shown in FIG. 6, there is an object 150 other than a boat, on the starting line at the beginning of a race, at the moment the boat first begins to cross the starting line the camera tube 153 picks up the image of the boat, and also picks up the image of the object 150. At the same time the image of the boat is picked up by the camera tube 154, since the boat extends from the starting line to the line scanned by the camera tube 154, but the camera tube 154 does not pick up the image of the object since the object 150 does not extend as far as the line scanned by the camera tube 154. The camera tubes 153, 154 therefore both produce outputs which relate to the boat and which are supplied through the video amplifier and wave shaping networks 155, 156 to provide input to both input terminals of the AND gate 157, which therefore supplies an input to the detection gate 105 or 106. But video signal output relating to the object 150 is produced by the camera tube 153 only, and so input is provided to one input terminal only of the AND gate 157. Therefore the AND gate produces no output, and the object 150 does not become the source of signals that could be misinterpreted as representing a boat, and precision of supervision of the race is greatly improved. It is assumed in the description above that the object 150 does not extend from the starting line to the scanned by the camera tube 154. However, the same principles as described above can be applied to eliminate the possibility of spurious signals from objects larger than the object 150 by increasing the distance between the starting line and the line scanned by the camera tube 154.

In another embodiment of the invention there are provided in association with the equipment of the 1st and 2nd embodiments means for making known by what amounts of time prior to or after a starting signal different motor-boats in a race cross the starting line and also what times different motor-boats take to complete a race. There means are shown in block diagram form in FIG. 7, and wave forms obtained therein are shown in FIG. 8.

In this embodiment, the standard time pulse emitter 104 has two more output terminals, 104-4, 104-5. Output from the terminal 104-4 is supplied to a video signal guide circuit 200 (described below) and to the register 14. Clock pulses are supplied from the terminal 104-5 to a time counter 204. Also the camera tube 100 scans both the starting and the finishing line of a race and output from the camera tube 100 is supplied through the video amplifier 102 and shaping circuit 103 to the circuit 200. The circuit 200 is for the purpose of directing video signal output from the camera tube 100 to different elements according to whether the camera tube 100 is scanning the start or the finish of the race. At the start of a race, when the camera tube 100 is scanning the starting line, video signal output produced by the camera tube 100 in response to different boats scanned is directed by the guide 200 to a boat number detection circuit 201, a boat number detection circuit 202, or a boat number detection circuit 203. The boat number detection circuits 201, 202, 203 respectively, are for the detection of numbers of boats that start too early, correctly, or late, and possess the same functions as the circuit elements which are subsequent to the wave shaping circuit 103 and are described in reference to the 2nd embodiment of the invention and shown in FIG. 3. Each detection circuit 201, 202, 203 and has two input terminals and produces output only

when there is input at both terminals. Input to one terminal of each detection circuit 201, 202, 203 is, as described, from the video signal guide circuit 200. Input to the other terminal of the detection circuit 201, 202, 203 is from the output terminal 104-1, 104-2, 104-3, respectively of the standard time pulse emitter 104. The detection circuit 201 therefore produces an output relating to boats starting too early, and to the order of boats starting too early, and the detection circuits 202, 203 produce output relating to boats that start correctly or late.

When the start of a race is completed, a changeover control input is supplied from the standard time pulse emitter terminal 104-4 to the register 14 and to the guide circuit 200. This control input clears the register 14, and causes the guide circuit 200 to change over and direct subsequent video signal output from the camera tube 100 to a boat number detection circuit 211. At the end of the race, therefore, the guide circuit 200 directs all camera tube 100 output to the boat number detection circuit 211, which is for the purpose of detecting the number of each boat as the boat finishes a race, and as boats finish their different numbers are recorded in the register 14, in the same manner as numbers were recorded at the start of the race.

Output from the detection circuits 201, 202, 203 is supplied to number recording command gates 205, 207, 209 respectively. Each command gate 205, 207, 209 has two input terminals and produces an output only when there is a simultaneous input at both terminals. Input to one input terminal of each command gate 205, 207, 209 is a clock pulse input from the standard time pulse emitter terminal 104-5, and input to the other terminals of the command gates 205, 207, 209 is supplied by output from the boat number detection circuits 201, 202, 203, respectively. Output from the command gate 205 thus provides commands to record the numbers of boats that start too early, output from the command gate 207 provides commands to record the numbers of boats that start correctly, and output from the command gate 209 provides commands to record the numbers of boats that start late. Output from the command gates 205, 207, 209 is supplied as input to timing registers 206, 208, 210, respectively. Each register 206, 208, 210 is composed of as many flip-flops as there are boat numbers it is desired to record, each has two input terminals, and each produces output only when there is a simultaneous input at both input terminals. Input to one input terminal of the register 206 is provided by output from the command gate 205, input to one input terminal of the register 208 is provided by output from the command gate 207, and input to one input terminal of the register 210 is provided by output from the command gate 209. Input to the other terminals of the registers 206, 208, 210 is provided constantly by time-count pulses from the above-mentioned time counter 204. The time counter 204 is set to start counting from the time motor-boats in a race are allowed to start moving, for example, from 2 seconds before the starting signal. The time of the starting signal is taken as 0 and the counter 204 counts from minus values up to 0 and then counts positive values from 0, i.e. the counter 204 counts from $-x$ seconds to 0, and from 0 up to $+x$ seconds. When the timing register 206 receives an input from the command gate 205 it produces an output which is supplied to a visual display means 214 to cause display of the number of the boat

responsible for the output from the command gate 205 (i.e. the boat starting too early and causing input to the detection circuit 201 simultaneously with input thereto from the standard time pulse emitter terminal 104-1) and also of the time prior to the starting signal the boat crossed the starting line. If more than one boat starts too early there is of course more than one input to the register 206 from the command circuit 205 more than one boat number and time are displayed by the visual display means. Similarly, input to the registers 208, 210 from the command gates 207, 209 results in output which is supplied to visual display means 215, 216 to cause display of the numbers of the boats that cross the starting line at or after the starting signal and also the time after the starting signal the different boats cross the starting line.

And the end of a race the video signal output produced by the camera tube 100 in response to boats crossing the finishing line and also the contents of the register 14 containing the numbers of the boats are supplied as input to the boat number detection circuit 211. In response the detection circuit 211 produces as output an output which is supplied to a command gate 212. The command gate 212 is for the purpose of providing commands for the recording of boat numbers and of the times different boats take to complete the race. The command gate also receives clock pulse input from the standard time pulse emitter terminal 104-5, and when there is simultaneous input at both terminals of the command gate 212, the command gate 212 supplies an input to one input terminal of a timing register 213. The timing register 213 has two input terminals and produces output when it receives input simultaneously at both input terminals. Input to the other input terminal of the timing register 213 is supplied constantly from the time counter 204. Output from the timing register 213 is supplied to a visual display means 217 to cause the number of each boat and the time at which boat completes the race to be displayed.

Below is given a description of the operation of the above-described equipment.

It is supposed that, in a race between six motor-boats I-VI, motor-boat I crosses the starting line before the starting signal is given, motor-boats II, III, IV, V cross the starting line at or within a specified time after the starting signal, and motor-boat VI crosses the starting line after the specified time after the starting signal. In other words, boat I starts early, boats II, III, IV, V start correctly, and boat VI starts late. Prior to the starting signal the boats I-VI line up ready to move, and also the counter 204 starts counting time. As the boats I-VI cross the starting line, the video output produced by the camera tube 100 in response to the images of the boats I-VI is supplied to circuit 201 for the detection of the numbers of boats that start early, to circuit 202, for the detection of the numbers of boats that start correctly, and to circuit 203 for detection of the numbers of boats that start late. Also the numbers of the boats I-VI are recorded in the register 14, and the settings in the register 14 and in the detection circuits are compared, to make known the position of the boats at the beginning of the race, as described earlier. The boat I causes an input to be supplied to the commands gate 205, and the command gate 205 provides an input to the register 206. The register 206 also receives time-count input from the counter 204 and supplies to a visual display means an input giving the number of the

boat I and also how many seconds before the starting signal the boat I crossed the starting line, and the visual display means shows the number 1 and the number of seconds before the starting signal. Thus it is immediately known that the boat I has started too early, and it is also known how many seconds too early the boat I has started. The boats II, III, IV, V are the source of inputs to the command gate 207, and in response the command gate 207 provides inputs to the register 208. The register 208 supplies to a visual display means input giving the boat numbers II, III, IV, V, and the number of seconds after the starting signal the boats II, III, IV, V crossed the starting line. The visual display means displays the corresponding information, and thus it is immediately known that the boats II, III, IV, V have made a correct start, and it is also known how long after the starting signal each boat II, III, IV, V crossed the starting line. The boat VI crosses the starting line later than the specified time after the starting signal and so causes an input to be supplied to the command gate 209. The command gate 209 supplies an input to the register 210, and in turn the register 210 supplies an input to a visual display means causing the display means to display the number 6 and also the number of seconds after the starting signal. Therefore, it is immediately known that boat VI has started late, and it is also known how many seconds late the boat VI has started. When all the boats I-VI have crossed the starting line, a pulse from the terminal 104-4 of the standard time pulse emitter causes the register 14 to be cleared and ready to record boat numbers again, and at the same time the video signal guide circuit 200 is switched so that it directs subsequent video signal output from the camera tube 100 to the detection circuit 211. Therefore, as each boat I-VI crosses the finishing line its number is recoded in the register 14 and also a corresponding input is supplied to the detection circuit 211. In response to each input the detection circuit 211 supplies an input to the command gate 212, the command gate 212 provides an input to the timing register 213, and the timing register 213 supplies to a visual display means an input giving the number of the boat concerned and also the time. Thus as each boat I-VI crosses the finishing line its number is immediately displayed together with the time.

In a 5th embodiment of the invention there are provided a counter means in a circuit race which keeps accumulative totals for the detection pulses of the colour television camera received relating to each individual participant, whereby the number of laps by each participant by any given time from the start of a race may be known. These means are shown in block diagram from in FIG. 9, and wave forms obtained therein are shown in FIG. 10. In this embodiment, there are shown three camera tubes with appropriate colour responses, a camera tube 1, for red, a camera tube 2, for green, and a camera tube 3, for blue. There are also provided a deflection circuit 11 which to maintain focus over the scanning lines of the camera tubes 1, 2, 3, and circuits 4, 5, 6 for gamma correction of primary colour signals from the camera tubes 1, 2, 3 respectively. The structure of the system thus far described is easily obtainable using a conventional colour television camera, of which either the horizontal or vertical deflection circuit is held passive. Output from the gamma correction circuits 4, 5, 6 is supplied as input to a colour discriminator 8, which possesses output terminals

8-1, 8-2, . . . 8-6, which correspond to the six colours attributed to the six objects (that is motor-boats) and which produce output in response to the different addition voltages produced from the camera tube assembly in correspondence to different proportions of primary colours in the colours of the six motor-boats; a suitable structure for the colour discriminator 8 is for example a combination of a matrix (adder) and an amplitude comparator. In this embodiment, an input signal corresponding to red produce a logic 1 at the output terminal 8-1, and similarly a logic 1 is produced at output terminals 8-2, 8-3, 8-4, 8-5, 8-6, in response to input signals for yellow, green, cyan, blue, magenta, respectively. Since the time required for the camera tubes to cover one scanning line is extremely short, when, for example, the red motor-boat crosses the finishing line being scanned by the television camera a series of pulses is produced at the output terminal 8-1 of the colour discriminator 8; but the purpose of detecting when the red motor-boat crosses the finishing line is to determine the number of laps the red motor-boat has completed, and therefore the output of the terminal 8-1 is supplied to a discriminating output shaping circuit 21-1 which reduces each set of pulses from the output terminal 8-1 to a single pulse of a set width to give an output indicative of one completed lap. In a similar manner, and for the same reasons, the outputs of the terminal 8-2, 8-3, . . . 8-6 are supplied to discriminating output shaping circuits 21-2, 21-3, . . . 21-6 respectively for reduction to single pulses.

Provided in further association with the discriminating output shaping circuit 21-1 there is a timing counter gate 22-1, a lap total counter 23-1, a 1st numeric display unit 24-1, a photoelectronic display unit 25-1, a clock pulse emitter 9, a chronometric counter 26-1, and a 2nd numeric display unit 27-1. The timing counter gate 22-1, which can suitably be an RS flip-flop, has two input terminals, a set input terminal which receives the output of the discriminating output shaping circuit 21-1, and a reset input terminal which receives input from the lap total counter 23-1 as described later. The lap total counter 23-1 receives input from the discriminating output shaping circuit 21-1 and in response produces an output which is supplied as input to the 1st numeric display unit 24-1, which is of suitable size and in a suitable location to be seen by spectators or others at a race, meeting; in other words, since output from the colour discriminator terminal 8-1, and output in response to this from the discriminating output shaping circuit 21-1 are produced each time the red motor-boat crosses the finishing line; the output from the lap total counter 23-1 to the 1st numeric display unit 24-1 is indicative of the number of laps completed by the red motor-boat. The lap total counter 23-1 also produces a logic 1 output which is supplied as input to the photoelectronic display unit 25-1 when the red motor-boat has completed a set number of laps, the number set being the complete number of laps required to be completed minus one, like the 1st numeric display unit 24-1, the photoelectronic display unit 25-1 is of suitable size and in a suitable location to be seen by spectators and others at a race meeting. When the red motor-boat has covered the total number of laps required to complete the race the lap total counter produces a logic 1 which is supplied as input to the reset input terminal of the timing counter gate 22-1, and in response to input from the lap

total counter 23-1, the timing counter gate 22-1 supplies an reset input to the chronometric counter 26-1 and also a reset input pulse to the lap total counter 23-1. From the beginning of the race, that is from the first time the red motor-boat crosses the start/finish line, the discriminating output shaping circuit 21-1 produces a logic 1 as output which provides a set input to the timing counter gate 22-1, which in response supplies a set input pulse to the chronometric counter 26-1, and the chronometric counter 26-1 starts counting input pulses received from the clock pulse emitter 9, and supplying a corresponding input to the 2nd numeric display unit 27-1, which like the other display units is of suitable size in a suitable location to be easily seen; the pulse repetition frequency of the clock pulses from the emitter 9 to the counter 26-1 is such that there is at least one pulse for the smallest unit of time it is wished to measure and record. The value displayed on the 2nd numeric display unit 27-1 thus indicates the time that has elapsed from the beginning of a race and also gives an indication of the time the red motor-boat has taken to complete the number of laps displayed on the 1st numeric display unit 24-1. Output of pulses from the chronometric counter 26-1 to the 2nd display unit 27-1 stops when the counter 26-1 receives an input from the timing counter gate 22-1 (produced in response to a course-completed input from the lap total counter 23-1) simultaneously with a clock pulse from the emitter 9, so that the display on the 2nd display unit 27-1 stops at a value which gives the total time the red motor-boat has taken to complete the course.

For the yellow, green, cyan, blue and magenta motor-boats, records and displays relating to the numbers of laps covered, entry into a final lap, and times taken to completed indicated numbers of laps or a whole course are similarly obtained by means of discriminating output circuits 21-2, 21-3, . . . 21-6, timing counter gates 22-2, 22-3, . . . 22-6, lap total counters 23-2, 23-3, . . . 23-6, 1st numeric display units 24-2, 24-3, . . . 24-6, photoelectronic display units 25-2, 25-3, . . . 25-6, the clock pulse emitter 9, chronometric counters 26-2, 26-3, . . . 26-6, similarly connected and provided in association with the output terminals 8-2, 8-3, . . . 8-6, respectively, of the colour discriminator 8.

Below is given an explanation of the operation of the above-described system.

The colour television camera is first set up in a position and in an alignment such that its camera tubes 1, 2, 3 can scan the start/finish line of a race. It is supposed that there are six motor-boats, as described above, taking part in the race, and that the complete race covers ten laps of a particular circuit. As each motor-boat first crosses the start/finish line a number of logic 1 pulses are produced at the output terminal 8-1, 8-2, . . . or 8-6 of the colour discriminator 8, as shown in FIG. 10. The first 1 pulse in each of these trains of pulses provides a set input pulse to the related discriminating output shaping circuit 21-1, 21-2, . . . or 21-6; between the time their respective motor-boats have completely crossed the start/finish line, and, after one lap, reappear at the start/finish line the circuits 21-1, 21-2, . . . 21-6 are reset. Logic 1 output pulses from the circuits 21-1, 21-2, . . . 21-6 provide set inputs to the chronometric counters 23-1, 23-2, 23-6. The counters 26-1, 26-2, . . . 26-6 start counting time in accordance with the clock pulses received from the clock pulse emitter 9, and supply inputs to the 2nd numeric display

units 27-1, 27-2, . . . 27-6 which therefore display successive accumulative totals of time that has elapsed from the time their respective motor-boats have first crossed the start/finish line. The lap total counters 23-1, 23-2, . . . 23-6 supply input indicative of laps completed by their respective motor-boats to the 1st numeric display units 24-1, 24-2, . . . 24-6; that is each time a passes the start/finish line after the start of the race the corresponding lap total counter, 23-1, 23-2, . . . or 23-6, supplies an input causing the value displayed by the corresponding 1st numeric display unit, 24-1, 24-2, . . . or 24-6, to be increased by one. When a motor-boat has completed nine laps, its lap total counter, 23-1, 23-2, . . . 23-6, supplies an input pulse to the corresponding photoelectronic display unit, 25-1, 25-2, . . . 25-6, which thereupon displays the words 'Final Lap' or any other suitable indication. At the moment each lap total counter, 23-1, 23-2, . . . , or 23-6, has counted ten laps, it supplies a reset pulse to the corresponding timing counter gate, 22-1, 22-2, . . . , or 22-6, which, in turn, supplies reset pulses to its corresponding lap total counter, 23-1, 23-2, . . . , or 23-6, and chronometric counter, 26-1, 26-2, . . . , or 26-6. Upon receiving reset pulses lap total counters and chronometric counters stop supplying input to the 1st and 2nd numeric display units, respectively, and therefore as successive motor-boats complete ten laps the values displayed on the 2nd numeric display units 27-1, 27-2, . . . 27-6 stop at the times taken for the ten laps.

Thus the state of a race at any time is easily ascertainable, even if there is a staggered start or if one or more participants in the race lap others; in addition, it is of course possible for display unit output to be linked to a print-out device, in order to obtain a printed record of times taken by different participants to complete various numbers of laps of a circuit.

In a 6th embodiment of the invention, motor-boats distinguished by different colours are also marked with a white portion, for example in the shape of a triangle, at their fronts, as shown in FIG. 11, so that as a motor-boat advances into the field of a television camera this white mark is scanned first, and then the distinguishing colour. The equipment of this embodiment as shown in FIG. 12 comprises that of the embodiment of FIG. 9 and also a white discriminator circuit 31, and a white-mark identifier circuit 32, which can be suitably formed by an accumulative counter circuit and is for the measurement of continually varying voltage changes. The white discriminator circuit 31 receives input from the gamma correction circuits 4, 5, 6, and when this input corresponds to white being scanned by the television camera the white discriminator circuit 31 produces a pulse output whose width varies with the amount of white being scanned and hence with the output from the gamma correction circuits 4, 5, 6, to the white discriminator circuit 31. When a motor-boat passes into the target area scanned by the television camera, that is as it crosses the start/finish line, the white area scanned by the television camera is at first only that at the apex of the white triangle, and the width of the white discriminator 31 output pulse is correspondingly narrow, but as the motor-boat continues to advance across the start/finish line the amount of white scanned increases and the white discriminator 31 output pulse width increases, as shown in FIG. 13. The whitemark identifier circuit 21 receives input from the white discriminator circuit 31, and accumulates this

input as shown in FIG. 14 and only produces an output when the accumulated voltage input has reached a set level, which in this case is when the total voltage supplied through the gamma correction circuit 4, 5, 6 and white discriminator circuit 31 corresponds to that produced by the whole of a white mark on the front of a motor-boat having been scanned. Output from the white-mark identifier circuit 31, is supplied to the colour discriminator 8. In this embodiment the colour discriminator 8 produces an output only when it receives a relevant input pulse from the gamma correction circuits and from the white-mark discriminator circuit 32. In other words, the colour discriminator output terminals function as coincidence gates, only producing output when they receive two inputs within a set time interval; for example, in order for the output terminal 8-1 to produce an output, there must first be an input from the white-mark identifier 32 and then within a set time, which is of course made very short, an input corresponding to red from the television camera through the gamma correction circuits. In this embodiment, therefore, even if reflected light or other objects producing a colour corresponding to a colour distinguishing a motor-boat is scanned by the television camera, no output is produced from the colour discriminator 8, since there is not a simultaneous white input sufficient to cause the white-mark identifier circuit 32 to produce an output.

In a 7th embodiment of the invention, which is shown in FIG. 15, motor-boats are distinguished by three strips of the colours red, green, blue in different orders, three colours permitting six motor-boats to be distinguished also as shown in FIG. 16, there is provided in association with the elements of the first embodiment a sequence discriminator circuit 41, which can be suitably formed by a combination of and circuits and delay circuits. The sequence discriminator circuit 41 receives input from the colour discriminator 8 and supplies input to the output shaping circuits 21-1, 21-2, . . . 21-6. Which output shaping circuit receives input from the sequence discriminator circuit 41 depends on the order of colour signals input to the circuit 41 from the colour discriminator 8. For example, supposing that the order of stripes on a motor-boat is such that the colours scanned by the television camera are blue, then green, and then red, timewise input to the sequence discriminator 41 will be that corresponding to blue, green, and red successively. In this case the blue input and green input are delayed suitable times by delay circuits and the three inputs supplied to an AND circuit which then supplied an output to the output shaping circuit which has been previously determined as the circuit corresponding to a motor-boat which is marked with strips in the scanning order blue, green, red; alternatively of course, it is possible to supply the sequence discriminator 41 output directly to the timing counter gates 22-1, 22-2, . . . 22-6, and lap total counters 23-1, 23-2, . . . 23-6.

As is clear from the explanation above the invention provides means whereby boats making a correct start in a race, or boats to be disqualified or notified of a late start are immediately detected. Not only are these boats detected but also it is immediately made known at what instants individual boats cross a starting line or finishing line. Compared with conventional means for supervising the starts of motor-boat races which involve taking and developing a photograph, obtaining an

enlargement, taking the print to the race officials, then examining the photograph, the present invention has the obvious merits that it is much faster, more precise, and more convenient.

In the system of the invention, distinguishing colours are not limited to those mentioned in the description above, which were selected merely for the purposes of explanation, but can be any colours selected in accordance with the wishes of those taking part in a race. In all cases the system of the invention provides an accurate means for judging races by giving immediate information on the numbers of laps covered and times taken by different participants in a race. Also, the elements of the system are simple, and the invention thus presents the advantages that less staff are required for managing races, and that necessary information is rapid and accurate.

Therefore, these changes and modifications should be construed as included within the true scope of the present invention unless otherwise they depart therefrom.

What is claimed is:

1. A race supervision system for races in which objects distinguished by different colours advance together essentially in alignment toward a reference line the system comprising a first colour television camera assembly means for movably scanning along the reference line and for producing video signal outputs in which the voltages vary in accordance with the proportions of primary colours present in the colours of objects scanned, a coded pulse generation means for producing coded pulse outputs which vary in accordance with variations in the output of said first colour television camera assembly means, a continuous timing pulse generation means for generating pulse trains in which each succeeding pulse is emitted as said first colour television camera assembly means scans each successive portion of the scanning line, and a recording means for recording coded signals when the timing pulses and the coded pulse outputs are supplied simultaneously thereto, said recording means having the contents thereof being arranged for reading out.

2. A system as recited in claim 1, further comprising a sequence register connected to said recording means for having the contents of said recording means shifted sequentially thereinto, said sequence register having the contents thereof arranged for reading out.

3. A system as recited in claim 1, further comprising pulse generating means for providing at least a first output of pulses prior to the starting signal of a race, a second output of pulses at the starting signal of the race and for a predetermined period of time subsequent to the starting signal, and a third output of pulses after the predetermined period of time of the second output, at least one gate means responsive to the output of said pulse generating means for supplying setting inputs to a register means, comparison means for comparing the contents of said register means and said recording

means and for supplying output signals to display means which vary in accordance with the states of said register means and said recording means.

4. A system as recited in claim 1, further comprising a second camera tube assembly means for scanning a line that is parallel to and separate from said scanning reference line of said first colour television camera assembly means, and an AND gate means for receiving outputs of both said first and second assembly means for producing an output only upon coincidence of inputs from said assembly means, which output serves for verifying the detection of an object in the race.

5. A system as recited in claim 1, further comprising time counting means for counting time intervals starting from a predetermined period of time prior to the starting signal of a race until a predetermined period of time after the starting signal of a race and for supplying input signals at different times to display means so that the times relative to a race starting signal that the objects of the race are viewed by said first colour television camera assembly means may be determined.

6. A system as recited in claim 1, further comprising time counting means for counting time from a predetermined period of time prior to the starting signal of a race until the completion of the race and for supplying inputs indicative of the time to display means, said display means simultaneously receiving together with the time signals, signals indicative of the different objects of the race such that the times the different objects cross the starting line of the race prior to or after the starting signal of the race in the times taken by the object to complete the race may be determined.

7. A system as recited in claim 1, further comprising timing counting which are actuated and stopped by signals from said first colour television camera assembly so that the times taken by different objects in the race to cover predetermined distances may be determined.

8. A system as recited in claim 1, further comprising wave shaping circuits, each of which is set by input pulses from said first colour television camera assembly means each time an object in the race enters said first colour television camera assembly means target area and is reset between succeeding times when the object enters the target area, counters for counting the number of output pulses from said wave shaping circuits such that the number of laps of a race circuit completed at any time by the different objects in the race may be determined.

9. A system as recited in claim 1, wherein said first colour television camera assembly means repeatedly scans a single reference line.

10. A system as recited in claim 7, further comprising display means connected with said timing counters for displaying the values of said timing counters.

11. A system as recited in claim 8, further comprising display means connected to said counters for displaying the value recorded by said counters.

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