# United States Patent [19]

**Conklin et al.**

[11] **3,729,315**

[45] **Apr. 24, 1973**


[54] **METHOD OF MAKING SCENES FOR A GOLF GAME**


[75] Inventors: **Robert M. Conklin,** Muskegon; **Robert I. Anderson,** Spring Lake; **Michael G. Gautraud,** Muskegon; **William H. Shimanski,** Norton Shores, all of Mich.

[73] Assignee: **Brunswick Corporation,** Skokie, Ill.



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[21] Appl. No.: **77,300**

[52] **U.S. Cl.** ..... **96/27 R,** 96/41, 96/46, 273/176 L, 273/185 A, 273/185 B, 353/11, 353/121

[51] **Int. Cl.** ..... **G03c 5/04**

[58] **Field of Search** ..... 96/41, 46, 27 R; 353/11, 30, 121; 273/176 L, 185 A, 185 B



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*Primary Examiner*—David Klein

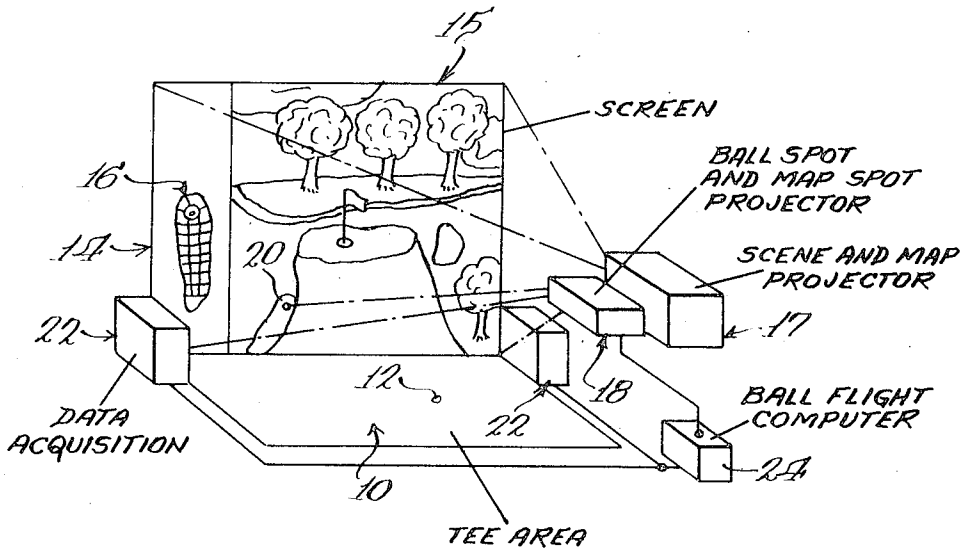
*Attorney*—Donald S. Olexa, Jerome M. Teplitz, John G. Heimovics and Hofgren, Wegner, Allen, Stellman and McCord



[57] **ABSTRACT**

A method of providing scenes for use in indoor golf games having a tee, a screen in front of the tee, a means for projecting on the screen any one of a plurality of scenes taken from different locations on a golf hole, data acquisition means and a computer associated therewith for computing the trajectory of a ball hit from the tee and a ball spot projecting means responsive to the computer for projecting a spot of light on the screen and on the scenes displayed thereon to illustrate the trajectory of the ball, which method permits the use of scenes from actual golf holes taken by photographic methods and eliminates inaccuracies in the ball spot projection that would normally be present due to the uneven nature of the terrain normally found on actual golf holes.


**14 Claims, 12 Drawing Figures**



5 Sheets-Sheet 1

Fig. 1.

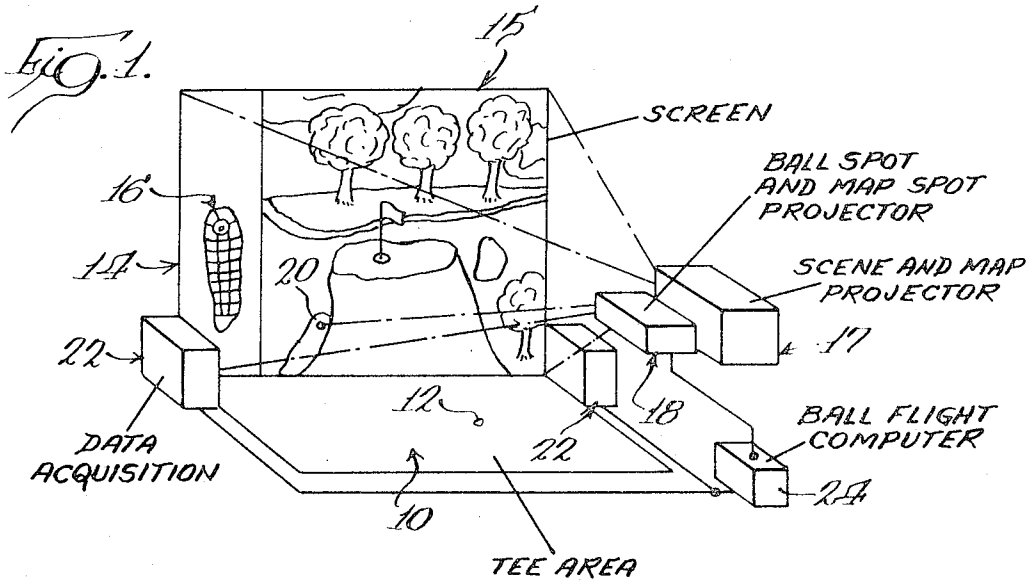
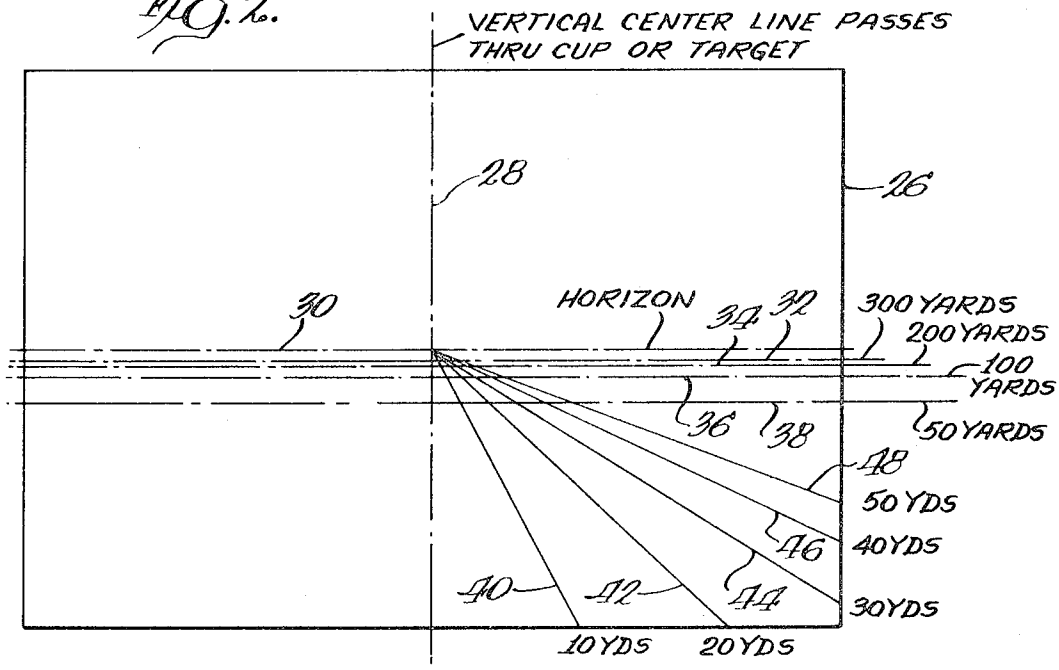



Fig. 2.



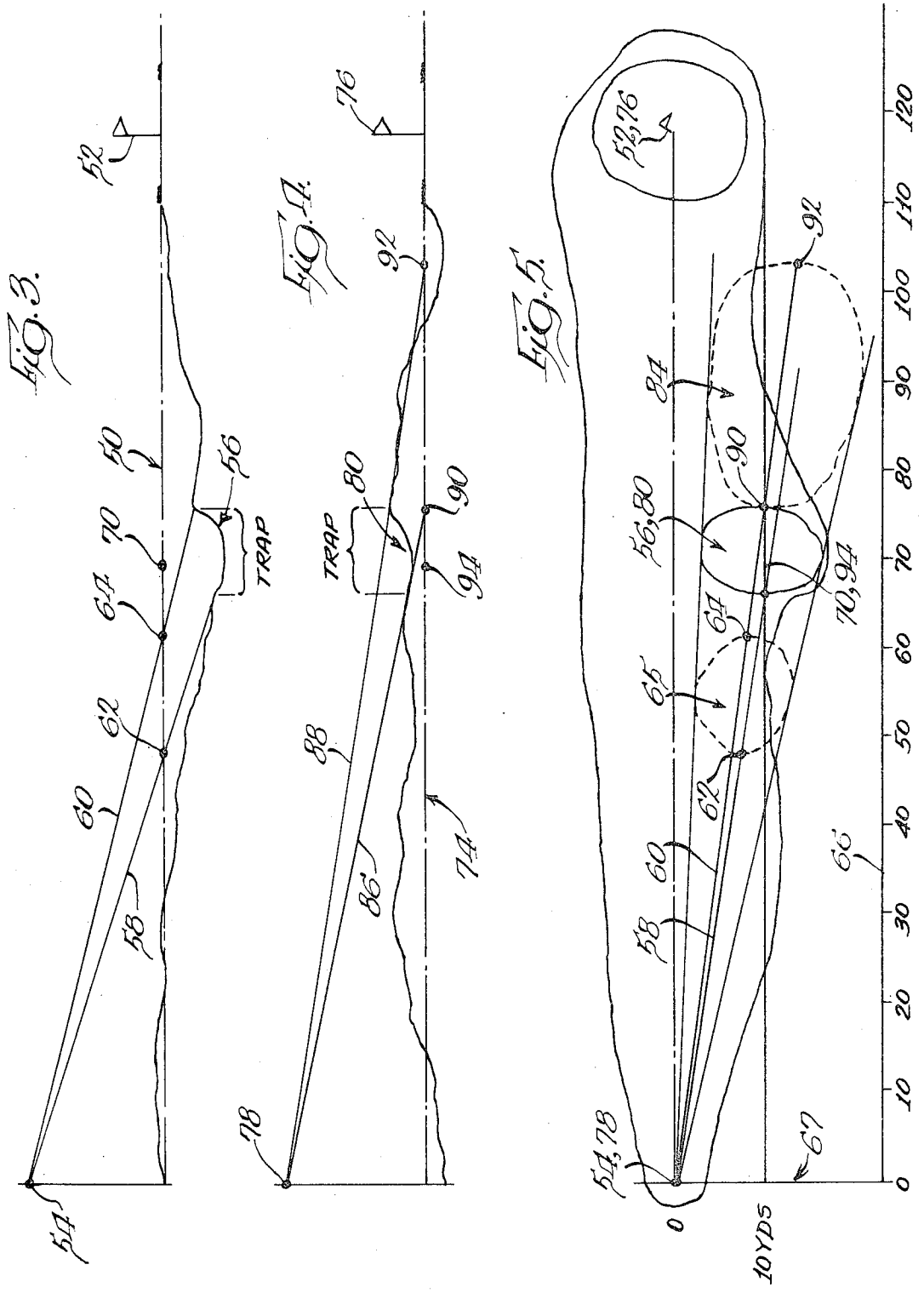

FIG. 3.
52
60
56
70
64
62
60
58
TRAP
54
FIG. 4.
76
92
TRAP
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90
94
88
86
74
78
FIG. 5.
52,76
92
84
90
56,80
70,94
64
65
62
60
58
66
54,78
67
0
10 YDS
120
110
100
90
80
70
60
50
40
30
20
10
0

Fig. 6.

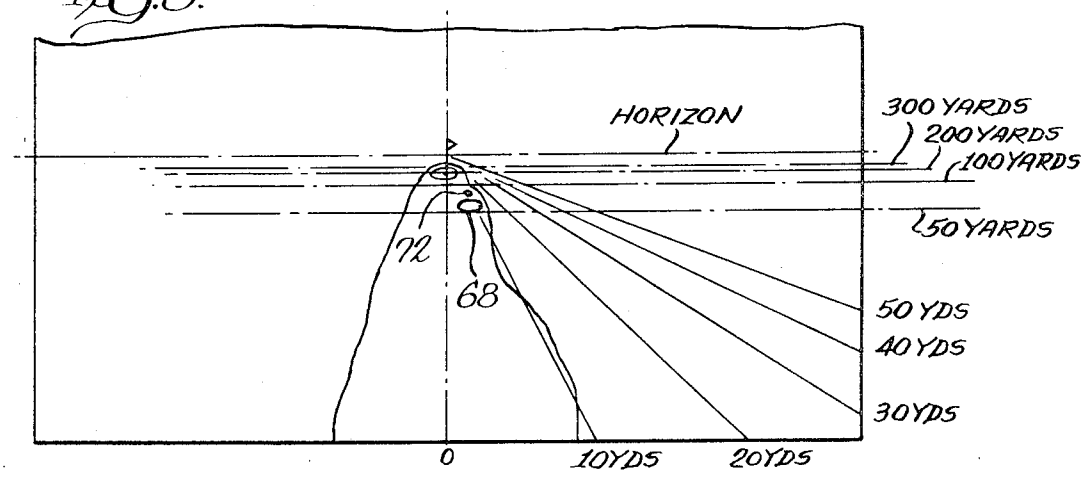



Fig. 7.

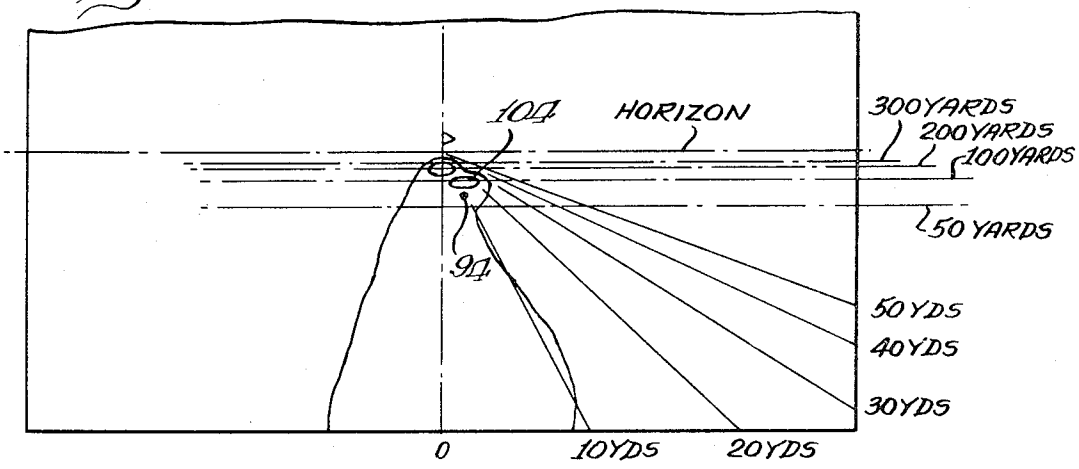
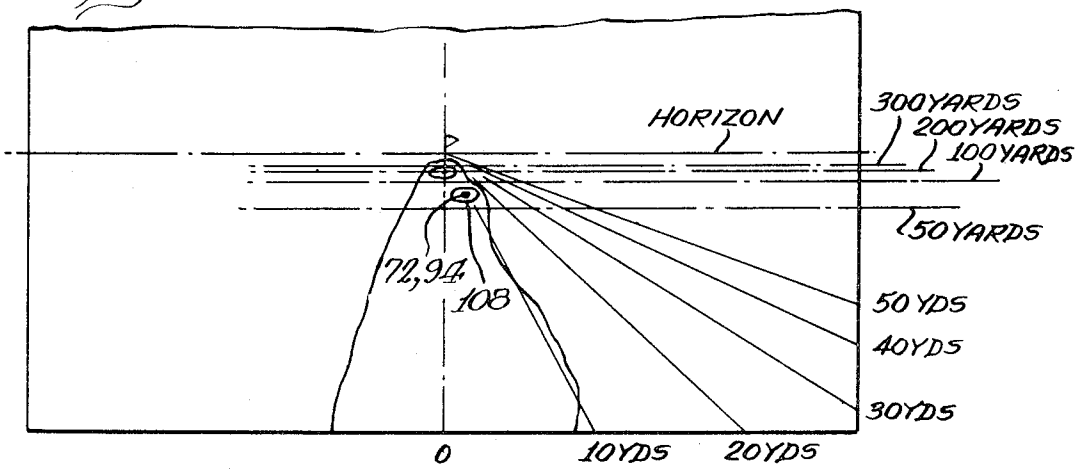



Fig. 8.



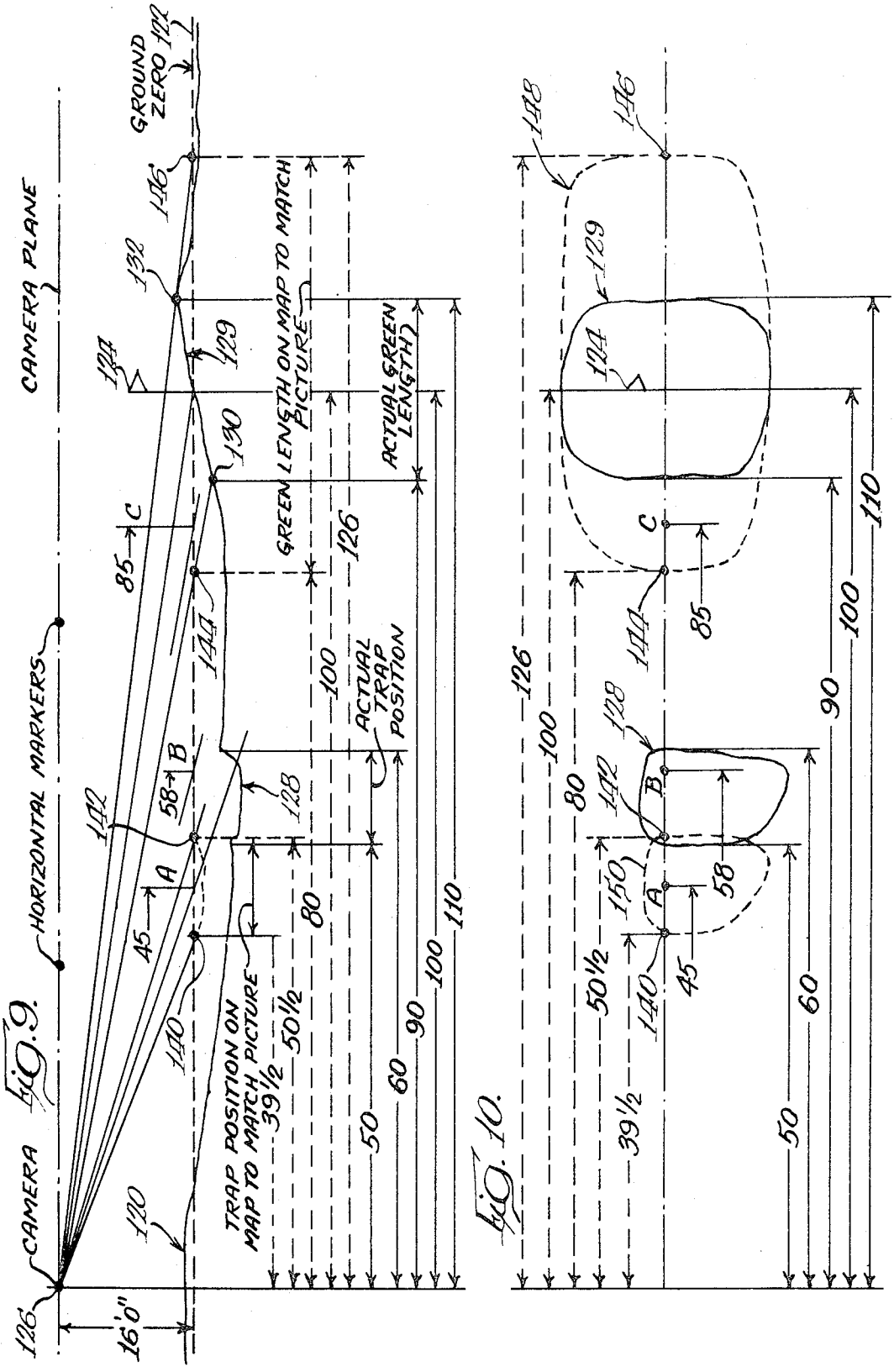

CAMERA PLANE
HORIZONTAL MARKERS
GROUND ZERO 122
CAMERA
126
16'0"
120
TRAP POSITION ON MAP TO MATCH PICTURE
GREEN LENGTH ON MAP TO MATCH PICTURE
ACTUAL GREEN LENGTH
ACTUAL TRAP POSITION
39½
50½
45
58
85
A
B
C
50
60
80
90
100
110
126
130
132
140
142
144
146
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150
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FIG. 9.

FIG. 10.

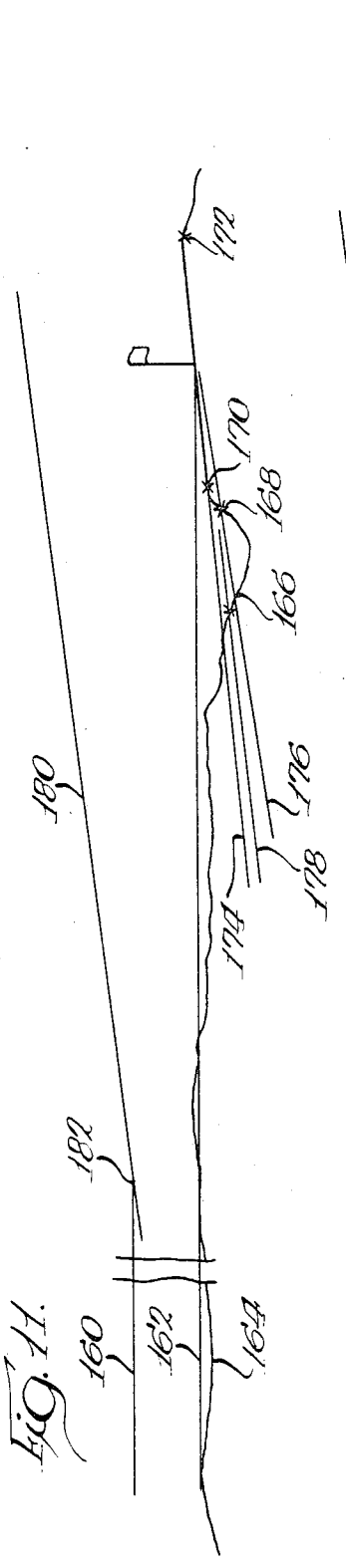

172
170
168
166
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182
160
162
164

FIG. 11.

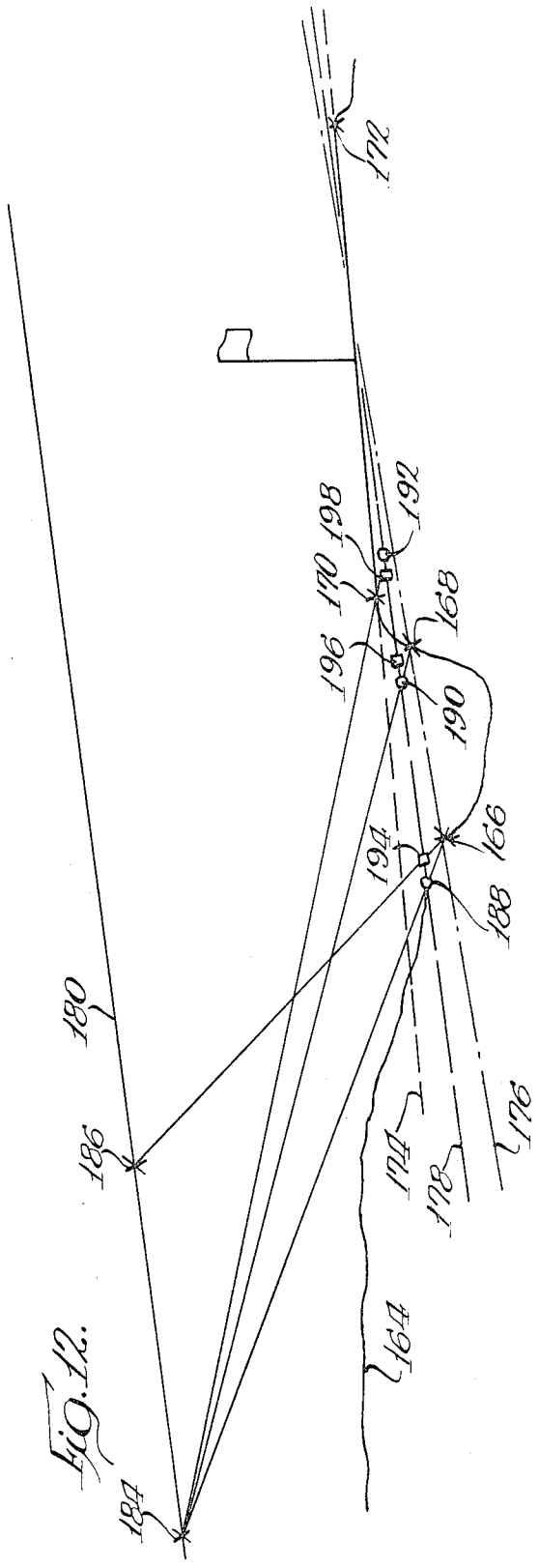

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FIG. 12.

# METHOD OF MAKING SCENES FOR A GOLF GAME

## BACKGROUND OF THE INVENTION

In order to eliminate the overcrowding of natural courses and to reduce the seasonal nature of the game of golf in many parts of the United States, it has been suggested that indoor golf games be provided to increase the number of golfing facilities available to golfers in a way that requires very little space.

A few indoor establishments have been operated on a commercial scale. One commercialized form of an indoor golf game provides a tee area from which the golfer may hit a golf ball towards the screen which has projected thereon a scene representing a portion of a hole on a golf course. As the golfer advances the ball toward the cup, the scene is changed to reflect the position of the golfer with respect to the cup and provide him with the view of the hole as it would be seen from the point where his shot would have come to rest so that he may play his next shot having an appropriate scene before him.

Computation means are used in conjunction with means for acquiring data relative to the initial trajectory of the ball hit from the tee area to compute the distance the shot would have traveled in order that the next scene may be selected. Additionally, the computed distance the shot would have traveled is displayed to the golfer.

Such systems have a significant drawback in that the nature of the flight of the ball throughout its entire flight is not displayed to the golfer except in terms of the final length of the shot and as a result, such games lack realism in that on an outdoor golf course, the golfer may visually follow virtually the entire flight of the ball.

It has therefore been proposed to eliminate the above noted lack of realism by providing a ball spot projector responsive to a computer which moves a spot of light on the projected scene in a manner to simulate the flight of the ball. While such systems have generally enhanced the realism provided by indoor golf games, uneven terrain illustrated in the scene, particularly with respect to hazards such as streams and traps, may result in a display that is so inaccurate as to be of virtually little help. As a result, if a ball spot projector is used indiscriminately in an indoor golf game, the inaccurate showing provided thereby may be such as to significantly irritate the golfer playing the game to the extent that he will not return so that any degree of extra realism provided by its presence is not sufficient to economically justify the additional equipment required for it.

Furthermore, if the ball spot projector is used in an indoor golf game system including map spot projection wherein there is provided a map of each hole on the course and the point of termination of each shot is indicated on the map, disagreement between the ball spot projector's indicated point termination on a projected scene and a map spot projector's indication of the point of termination on a map will often cause a severely hostile reaction on the part of a golfer.

One way of overcoming an an inaccurate showing by a ball spot projector is to assume that the course being played is flat and the same is described in detail in the copending application of Conklin, Ser. No. 685,176,



filed Nov. 22, 1967, entitled "Golf Game" and assigned to the same assignee as the instant application. Of course, when the assumption is made that the course is generally flat, the scenes chosen must be such as to depict a substantially flat course and only slight changes in the terrain above or below the reference plane may result in the inaccuracies mentioned previously. And because very few, if any, courses have perfectly flat holes wherein even the landmarks such as traps lie in a single plane, it was necessary to find another manner of providing the scenes depicting the view of a flat course. In the Conklin application, a model flat course was built on a reduced scale utilizing conventional modeling techniques and the resulting model was then photographed to provide the scenes.

While the resultant scenes are quite satisfactory and the average golfer cannot discern that the same were not taken on an actual course, the same do not appear as "crisp" in detail as would scenes taken on an actual course. Similarly, because the scenes represent a model of a course, the colors of the scenes are not completely natural. Furthermore, certain details readily observable on a natural course are not generally missed by an observer of a scene made from a scale model, but nonetheless influential on the factor of realism, are omitted when the modeling technique is used. For example, there may be missing depictions of ball washers adjacent tee areas, tee markers, mower patterns and golf cart tracks.

## SUMMARY OF THE INVENTION

The instant invention seeks to provide scenes for use in indoor golf games which have all the attributes of those previously used which depict a flat course yet are taken on a natural course so that detail of each scene is "crisp" and the color thereof is vivid and natural; and further include depictions of other minor elements customarily observed on a natural golf course to enhance realism.

In one embodiment of the invention, the foregoing is accomplished by determining a reference plane which need not be horizontal and which generally will pass through the location of the cup on the green; then, from the point on the course from which the scene is to be taken, which will generally be a few feet above the reference plane, projecting the boundaries of the landmark on the reference plane at a direction transverse thereto; taking a photograph of the hole from that point with the optical axis of the camera parallel to the reference plane and generally passing through a line drawn upwardly from the cup and perpendicular to the reference plane; and then retouching the photographs thus made by deleting the landmark at its actual location and reinstating it on the photograph where it would appear thereon if it were located at the point of projection on the reference plane.

In a second embodiment of the invention, a similar reference plane is chosen; each scene is photographed from a viewpoint chosen in the manner set forth in the preceding paragraph; and, from the viewpoint for each zone, the landmarks are projected on the reference plane. Then, rather than altering the photographs, a new map of the golf hole is drawn utilizing the boundaries of the landmark as they are projected on the reference plane to the viewpoint and the map thus con-

figured is then used in a golf game along with means to indicate the point of termination of each shot on the map. In this way, the indication of the point of termination on the map will be consistent with the point of termination indicated on the projected scene by the ball spot projector. This method is particularly advantageous when used in conjunction with those golf games that not only project the scene for the golfer, but the map as well, in that the particular map projected can be unique to each scene in small variations in the maps from scene to scene for the particular golf hole will go unnoticed by the golfer.

Neither embodiment of necessity requires that but a single reference plane be used for each hole to be photographed. Rather, each photograph could be taken with a reference plane unique to it. Normally however, no more than two reference planes will be employed on each hole, one for the fairway up to a point within 100–200 yards of the green and another for the portion of the hole near the green within the 100–200 yard range mentioned previously. Furthermore, if that portion of the fairway remote from the green is relatively level and/or is relatively free from landmarks such as sand traps, a reference plane may not be necessary. However, according to the invention, it is almost always desirable to select a reference plane for photographs of that portion of the hole within 100–200 yards of the green.

Also, when two or more reference planes are employed on one hole, they need not be parallel.

When the golf game includes a map of the hole as well as the scenes, quite frequently both of the foregoing methods may be advantageously employed together with the retouching of the photographs minimizing map changing requirements and map changing minimizing the amount of retouching required.

## DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view illustrating in schematic form an indoor golf game in which the instant invention may be used;

FIG. **2** is a graph which may be used in practicing the first embodiment of the invention;

FIG. **3** is a schematic, side elevation of a golf course illustrating one step in the first embodiment of the invention when the landmark is below the reference plane;

FIG. **4** is a schematic, side elevation of a golf course illustrating one step in the first embodiment of the invention when the landmark is above the reference plane;

FIG. **5** is a plan view of the golf hole illustrating the actual location of the landmark as well as the projected location of the landmark on the reference plane as determined by the step illustrated in FIGS. **3** and **4**;

FIG. **6** illustrates one way in which the natural scene would appear without alteration according to the first embodiment of the invention;

FIG. **7** illustrates another view of how a scene would appear without alteration according to the first embodiment of the invention;

FIG. **8** illustrates how the scene would appear after alteration according to the first embodiment of the invention;

FIG. **9** is a side elevation of a portion of a golf hole illustrating the performance of a step in the method according to the second embodiment of the invention;

FIG. **10** is a plan view of a golf hole illustrating the results of the performance of the steps illustrated in FIG. **9**;

FIG. **11** is a side elevation of a portion of a golf hole illustrating a modification of either the first or second embodiment of the invention; and

FIG. **12** is an enlarged side elevation of a portion of the golf hole shown in FIG. **11** and illustrates how the modification would effect the scene.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

### General

An example of a typical indoor golf game installation with which scenes and/or maps made according to the invention are intended to be used is illustrated in FIG. **1** and is seen to comprise a tee area, generally designated **10**, having a tee point **12** at which a golf ball may be placed to be hit by the golfer. In front of the tee area **10** is a screen, generally designated **14**, which has a scene, generally designated **15** and a map of the golf hole, generally designated **16**, projected thereon by a scene and map projector, generally designated **17**. A ball spot and map spot projector, generally designated **18** is also provided to project a spot of light **20** on the scene **15** or on the map on the screen **14** in a manner that simulates the flight of a golf ball or depicts the point of termination of the shot on the map, respectively.

Data acquisition equipment, generally designated **22**, may be located between the tee point **12** and the screen **14** or behind the screen **14**, or both, for measuring parameters of the trajectory of a ball hit from the tee point **12**. The trajectory information thus acquired is then fed to a computing apparatus **24** which continuously computes the trajectory of the ball hit from the tee point **12** throughout the flight thereof based on the parameters and provides an output to the ball spot and map spot projector **18** so that the spot of light **20** will be moved accordingly to illustrate the flight of a ball. When the flight is terminated, the ball spot will be stationary for a predetermined period and then will be shifted to the left as viewed in FIG. **1** to indicate the point of termination of a shot on the map **16**.

In order to insure accurate alignment of the projected scene on the screen **14** so that the final resting point of the spot **20** either on the scene **15** or the map **16** is indicative of the true point of termination of a shot, the projector **17** includes a means for accurately aligning the projected scene **15** and the map **16** on the screen and may be of the type disclosed in the copending U.S. application of Pratt et al., Ser. No. 574,218 now U.S. Pat. No. 3,528,733,, filed Aug. 22, 1966, entitled "Visual Display System" and assigned to the same assignee as the instant application. Furthermore, in order to insure that the final resting place of the spot **20** on the scene **15** is related to the distance the ball would have travelled, a means for controlling the final position of the projected spot **20** with respect to the vertical in proportion to the computed distance the shot would have travelled should be provided. Suitable means for this purpose are disclosed in the copending U.S. appli-

cation of Russell and Baldwin, Ser. No. 588,922 now U.S. Pat. No. 3,513,707,, filed Oct. 24, 1966, entitled "Golf Game Computing System" and assigned to the same assignee as the instant application. Finally, in order to provide for the shifting of the projected spot **20** by the ball spot and map spot projector **18** from the scene **15** to the map **16**, the Russell and Baldwin computing system should be modified as disclosed in the copending U.S. application of Russell and Feeney, Ser. No. 855,150, now U.S. Pat. No. 3,589,732, filed Sept. 4, 1969, entitled "Map Spot Projection System for a Golf Game" and assigned to the same assignee as the instant application. At this point, it should be noted that the last-named system need not be incorporated if it is desired to utilize the map system disclosed in the Russell and Baldwin computing application. However, particularly when the second embodiment of the method to be disclosed herein, the alteration of the map to suit the scene, is employed, it is highly advantageous to use the Russell and Feeney system.

Of course, in order to insure proper correlation between the projected scene on the screen **14** and the spot **20** projected by the ball spot projector **18**, it is necessary that certain relations seem to exist. Such relationships are of the nature of physical location of the elements with respect to each other rather than of electrical or mechanical interconnections and are disclosed in the above-identified Pratt et al. and Russell and Baldwin applications. For the purpose of the instant application, it is sufficient to say that the accurate aligning means of the Pratt et al. application insure that each scene will occupy the same area on the screen while the ball spot and map spot projector **18** used with the means for controlling the final position of the projected spot **20** disclosed by Russell and Baldwin is physically arranged with respect to the screen **14**, and thus to the projected scene, so that the final position of the projected spot **20** will always be at the same location on the screen **14** for identical shots. That is, a 200 yard shot hit 10 yards to the right of a line extending between the tee point **12** and the base of the flag illustrated in any scene projected on the screen **14** will always result in the projected spot **20** being at a particular location on the screen **14**. Thus, through the use of the above-identified means in Pratt et al. and Russell and Baldwin identical shots will always be indicated in an identical manner on the same scene.

When the above-mentioned means disclosed in the above-cited Pratt et al. and Russell and Baldwin applications are used, the realism of the simulated ball flight protrayed by the projected spot **20** is considerably enhanced over that achieved in prior art ball spot projecting systems. When scenes are provided according to the manner described in the above-cited Conklin application, the realism of the simulated ball flight is even further enhanced although the projected scene may lack some "crispness" and be somewhat bland in color.

As mentioned in the Conklin application, even if the above-mentioned means of Pratt et al. and Russell and Baldwin are utilized, inaccuracies in the final location of the projected spot **20** may exist if the scene projected on the screen **14** is not appropriately chosen. The reason for this will become apparent from the brief discussion of the content of the above-cited Russell and Baldwin application. The Russell and Baldwin computing device computes continuously throughout the flight of the ball, three coordinates of the ball in space. The first coordinate is the so-called "X" coordinate which is the distance to the right or left of a straight line extending from the tee point **12** to the representation of the cup on the green on the hole of a golf course. The second coordinate is the so-called "Y" coordinate which is the distance of the ball above or below a horizontal plane. The third and final coordinate is the so-called "Z" coordinate which is the distance from the tee point along the straight line mentioned in conjunction with the description of the X coordinate.

In order to indicate the final location of the ball by movement of the projected spot **20**, the Russell and Baldwin computer provides information as to the X, Y and Z coordinates, when the ball has come to rest. For a plurality of differing shots made from the same tee point, it would be apparent that the coordinates at the point of termination for each shot would differ from the coordinates of the point of termination of each other shot if the terrain on the golf course was uneven. That is, a ball at rest in a valley on a golf course would have a different Y coordinate than a ball coming to rest on a hill; a ball directed to the right would have a different X coordinate than a ball directed to the left; and a "dubbed" shot would have a different Z coordinate than a "-super" shot.

Of the three coordinates, only the final Y coordinate is completely dependent upon the terrain of the golf course, the final X coordinate being principally dependent on the initial direction and velocity of the shot and side spin, if any, and the final Z coordinate being principally dependent upon the initial angle of elevation, the initial direction, and the initial velocity of the shot.

The final Y coordinate is dependent upon the terrain of the course because the ball will always come to rest on the ground and the terrain of the course would normally vary for each combination of X and Z coordinates. Thus, in order to compute the final Y coordinate, it would be necessary to provide a vast memory system containing information as to the Y coordinate of ground level for each combination of varying X and Z coordinates. One will immediately recognize that the provision of such a memory in an operable system would be an extremely complex undertaking fraught with many problems. Furthermore, even if such a memory system could be used in conjunction with the computing system, those skilled in the art will recognize that the provision of the same would so greatly increase the cost of components of the golf game that the same could not be manufactured on a commercial basis sufficiently economically so that golfers could play the game at a reasonable price.

In order to obviate the need for such huge memory facilities, the Russell and Baldwin computation system assumes that the terrain on the course has the same Y coordinate for all combinations of all X and Z coordinates. In other words, the Russell and Baldwin computation system assumes that the playing surface of the course is flat. As a result of such an assumption, the computation system is significantly simplified. Specifically, instead of providing a vast number of bits of information relative to the Y coordinate of the terrain of the golf course at each of a plurality of X and Z coordinates for each of 18 holes, it is only necessary to pro-

vide a single bit of information which absolutely identifies the Y coordinate for each and every combination of final X and Z coordinates for each of 18 holes.

In the preferred embodiment disclosed in the Russell and Baldwin application, and as mentioned above, the final position of the projected spot **20** with respect to the vertical on the screen **14** is varied according to the computed distance that the shot would have travelled. And since the computation system considers that the course is flat at all points thereon, for all shots having the same final Z coordinate, the projected spot **20** will be at the same height on the screen **14**, irrespective of the X coordinate.

If, however, the terrain of the projected scene on which the spot is moved is non-uniform, the final position of the projected spot may give the golfer the illusion that he either hit the ball further than he actually did or that he did not hit the ball as far as he actually did. This illusion is particularly true when non-uniformities in a golf hole such as landmarks and/or hazards are in the projected scene.

More specifically, it will be appreciated that the height of those continuous portions of a golf course hole which are uninterrupted by landmarks such as water hazards, traps and trees, is not as apparent in the scene because of the continuous nature of the surface being viewed. However, when there is an interruption, normally in the form of a landmark, then the viewer of the scene may more readily identify the height of the continuous portion of the golf course hole using the landmark as a reference point. Because the scene viewed by the golfer is only in two dimensions in the indoor golf game, advantage may be taken of the relative inability of the golfer to ascertain the relative height of the playing surface at points somewhat distant from a landmark. However, because the presence of such landmarks cures the inability of the golfer to perceive the height of the playing surface, according to the first embodiment of the invention, the location of the landmark is appropriately changed on the scene by photo-retouching methods of a conventional nature. That is, since the uninterrupted continuous portion of a golf hole will appear to be relatively planar when illustrated in two dimensions, by photo-retouching methods certain landmarks that do not appear to be in the relatively planar appearing continuous, uninterrupted playing surface are deleted from the scene and relocated therein so that the same appear to be in the same apparent plane as the playing surface. The manner in which the same is accomplished will now be described in detail.

FIG. **2** illustrates a graph which may be generated by the golf game computer and which may be used in retouching scenes according to one embodiment of the invention or in drawing maps in the other embodiment. The graph is bounded by a rectangle **26** which has its sides proportional to the sides of the scene to be projected on the screen and when used in the retouching process, will be of the same size as the photo negative or positive to be retouched.

When a computational system such as that disclosed in the Russell and Baldwin application is to be employed in the golf game, the rectangle **26** is divided into four equal quadrants by a vertical line **28** and a horizontal line **30**. And, in general, photographs will be taken so that the horizon in each scene will lie along the horizontal line **30** while the flag stick (or, in the case of a hole where the flag stick is not visible, the center of the fairway) will lie along the vertical line **28**. That is, the camera is accented so that this arrangement will permit equal indication on the scenes of shots directed both to the right and the left and will further permit a full display of the position of the ball in flight.

A number of horizontal yard lines **32–38** are also placed on the graph to indicate the final position of a projected spot with respect to the vertical on a projected scene for shots hit varying distances. For example, a shot having a final Z coordinate of 300 yards would lie in some position along the line **32**, the precise point being determined by the X coordinate. Similarly, shots having a final Z coordinate of 200 yards, 100 yards and 50 yards would be indicated as lying along the lines **34–38** respectively.

Diagonal lines **40–48** represent the focus of points of indication of shots having various final X coordinates. For example, a shot having a final X coordinate would lie somewhere along the line **42**, its precise position on that line being determined by the final Z coordinate.

The lines **32–48** may be generated by the golf game computing ball spot projecting system in a relatively simple manner. For example, the line **40** may be generated by pinning a voltage representative of the X coordinate at a level corresponding to a **10** yard displacement to the right and the Z coordinate voltage changed through the range of zero volts to a voltage representing the maximum Z yardage possibly attainable in the game. By the same token, one of the yard lines is the line **38** to be generated by maintaining the Z voltage output at a consistent voltage representing 50 yards while varying the X coordinate representing voltage through its permissible range.

From the foregoing, it will be appreciated that the graph provides a scale for a perspective scene which enables the determination of whether a trap, for example, at a Z coordinate of 200 yards and an X coordinate of 20 yards on the actual golf course being photographed will in fact appear at that location on the scene when employed in conjunction with the ball spot projector. If not, the scene may be retouched by deleting the trap from its actual position and reinstating at the position it would appear if the terrain were uniform. Alternatively, the apparent position of the trap on the scene may be noted and, when drawing up a map for use in the game, located on the map in its apparent position as viewed in perspective as opposed to its actual position if viewed in a plane.

FIGS. **3–7** illustrate the type of error normally found in unretouched photographs which the graph illustrated in FIG. **2** may be used to correct to provide scenes for indoor golf games. FIG. **3**, for example, includes a reference plane **50** chosen to intersect the base of a flagstick **52** marking cup location. Oppositively of the flagstick **52** is a viewpoint **54** which represents the location of a viewer's eye. Interposed between the viewpoint **54** and the flagstick **52** and below the reference plane **50**, is a trap, generally designated **56**.

The apparent position of the trap **56** may be ascertained by projecting the same on the reference plane **50** with respect to the viewpoint **54**. This is accomplished by extending lines from the viewpoint **54** to the boun-

daries of the trap **56** and noting the points of the intersection of such lines with the reference plane **50**. As viewed in FIG. **3**, lines **58** and **60** have been drawn and respectively intersect the reference plane **50** at points **62** and **64**.

Turning to FIG. **5**, the projected location of the trap **156** on the reference plane **50** is seen in plan view and is generally designated **65**. In FIG. **5**, it will also be noted that there is provided a Z scale **66** and an X scale **67** to indicate the location of the trap **56** and the projection **65** thereof on the reference plane **50**.

More specifically, it will be seen that the actual location of the trap **56** measured with respect to the viewpoint **54** is approximately ten yards to the right thereof and about 70 yards straightaway therefrom. In contrast, the projection **65** of the trap **56** is located about 55 yards away from the viewpoint **54** and about 7½ yards to the right thereof.

The net result of the fact that the trap **56** does not actually lie within the reference plane **50** on a perspective scene may be observed from FIG. **6**. In FIG. **6**, the apparent location of the trap **56** is designated **68**. The position of the trap **56** were it actually in the reference plane **50** is shown by dotted lines designated **68'** in FIG. **6**.

The problem in indication if a perspective scene of the terrain illustrated in FIG. **3** without correction were used will now be explained. Let us assume that a golfer hits a shot 10 yards to the right and 70 yards long. From the foregoing description of the location of the trap **56**, it will be appreciated that such a shot will terminate in approximately the center thereof. Obviously then, a ball spot projector should project a spot of light to the center of the trap on the projected scene. But it will be recalled that the Russell et al. computer which controls the ball spot projector considers that all shots terminate in a single plane having a single Y coordinate and for purposes of illustration, may be assumed to be coincident with the reference plane **50**. Thus, as viewed in side elevation, the projected spot of light will be approximately at a point **70** illustrated in FIG. **3**. The point **70** is also seen in FIG. **5** and if a map spot projection system is used which is along the lines of that mentioned in the Russell et al. application, the shot will be illustrated on the map as terminating in the center of the trap **56**. However, in perspective and with reference to FIG. **6**, the final location of the projected spot will be at a point **72** which is behind the actual indication **68** of the trap **56**.

In a game utilizing both a ball spot projector and a map spot projector, such inconsistent indications detract significantly from the realism of the game.

A similar error will be apparent from a consideration of FIGS. **4**, **5** and **7**. In FIG. **4**, there is again provided a reference plane **74** which extends to the base of a flagstick **76**. Remote from the flagstick **76** is a viewpoint **78** and intermediate the viewpoint **78** and the flagstick **76**, and above the reference plane **74**, is a trap, generally designated **80**. For convenience, the actual location of the trap **80** in terms of X and Z coordinates is identical to that of the trap **56**. However, inasmuch as the trap **80** is above the reference plane **74** while the trap **56** is below the reference **50**, the projection of the trap **80** will be behind the actual location of the same rather than in front of the actual location as was the case for the terrain depicted in FIG. **3**.

Referring to FIG. **5**, the actual location of the trap **80** is generally designated **84** and is ascertained by the use of lines **86**, **88** extending from the viewpoint **76** to the periphery of the trap **80** and intersecting the reference plane **74** at points **90** and **92** in the same manner described above in conjunction with FIG. **3**.

If it be assumed that a similar shot (70 yards out and 10 yards to the right) was hit over the terrain illustrated in FIG. **4**, the Russell et al. computer would consider that the ball would come to rest, as viewed in side elevation in FIG. **4**, at a point **94** on the reference plane **74**. In plan view, the point **94** would be as indicated within the trap **56**, **80** in FIG. **5** while perspective view, as viewed in FIG. **7**, the point **94** would be located forwardly of the actual indication **104** of the trap **80**.

With reference to FIG. **8**, if the location of either of the traps **56** and **80** in perspective was corrected according to the invention, the same would be seen to be defined by a circularly shaped indication **108** and in such a case, the final position of the projected spot **72** or **94** would be located within the confines of the indication **108**. There is therefore provided a correct indication and one that is consistent with an indication provided by a map spot projector or the like.

The manner in which the practice of the invention according to a number of different embodiments will now be described.

### Selecting a Golf Hole to be Photographed

In selecting a golf hole to be photographed, there are a number of criteria that, if applied, simplify the practice of the method of making photographs to be described hereinafter. Specifically, it is highly desirable to select a golf hole which does not have abrupt changes in terrain. Some changes in terrain can be accommodated if the same are no more than what could be characterized as resulting in a gently rolling plane surface. For example, in practice, a hole having a playing surface, all parts of which do not deviate from a plane by more than 10 feet, has proved satisfactory. Of course, holes having greater deviations could be used but the foregoing criteria, if followed, minimizes the need for retouching fairway scenes, particularly those taken from a distance of 100 yards or more from the green.

It is also desirable that the hole selected have a green area (including surrounding traps) wherein the average plane of the green is three feet or less distance from the average plane encompassing the peripheries of the traps. For most golf holes, this will mean that the plane encompassing the periphery of a trap be three feet or less below the plane of the green.

A further criteria involves the pitch of the green. Normally, the rear edge of the green will be above the front edge of the green so that the average plane encompassing the green surface will be pitched toward the fairway. It has been found that a green so pitched may be satisfactorily photographed when there is a 4 foot or less difference in height for each 30 yards of green surface. Thus, for a green 90 feet from front to back, if the back edge were to be no more than 4 feet above the front edge, the practice of the method is simplified.

Of course, the foregoing criteria are merely representative of holes on which scenes have been satisfactorily made and it is to be understood that holes

having greater deviations could be employed although increasingly complicating the performance of the method.

## Correcting the Photographed Scenes

After a suitable hole has been selected, a map is made of the same and is arbitrarily divided into a number of zones in any desired manner. Thereafter, similar zones are laid out on the actual hole and a photograph of the hole from some desired point on the hole in each zone is then taken.

In the course of taking photographs of the hole, it is generally desirable to select a reference plane which passes through the cup of the hole and, in the course of taking photographs, orient the camera such that the optical axis thereof is parallel to the reference plane and directed toward an upward projection of the flagstick of the hole. The height of the camera above the reference plane may be maintained constant with respect thereto for all zones although, if the foregoing criteria are used in selecting the hole for photographs taken from points on the hole 100 yards or more away from the green, the height of the camera may be constant with respect to the playing surface of the hole. When the constant height relation is maintained with respect to the reference plane, the distance between the camera and the playing surface will differ depending upon the deviation of the playing surface at that point from the reference plane.

Whether the height of the camera is maintained constant with respect to the playing surface or to the reference plane depends, in part, upon whether the foregoing criteria are followed in selecting the hole. Another factor is the actual distance between the camera location and the reference plane or playing surface. If the distance is relatively small as, for example, 5 feet, and there are no landmarks within 100 to 200 yards, one may generally maintain the camera height constant with respect to the playing surface. However, if the distance is relatively great as, for example, 16 feet and there are sizable landmarks within 100 to 200 yards, it may be desirable to maintain camera height constant with respect to the reference plane.

As a result of the foregoing, there will be provided a number of photographs of the hole, one for each zone. Referring to the map of the hole, the location of each hazard such as a sand trap or a stream or the like with respect to a line extending between the point in the zone from which the photograph was taken and the cup of the hole is ascertained. Such a line corresponds to the Z axis of the shot.

Using such information, and a graph such as that illustrated in FIG. **2** along with the photograph, it can be determined whether the depicted location of the trap in the perspective view photograph corresponds to its correct location as ascertained from projecting the boundaries of the trap to the reference plane in a direction normal thereto to the map. If the two coincide, nothing further need be done. On the other hand, if the two differ, then by conventional photo-retouching techniques, the actual indication of the trap on the photograph is removed and replaced by a fairway or rough indication, etc., as appropriate. Then, the indication of the trap or other hazard is added to the photograph, again by conventional photo-retouching techniques, at the correct location on the perspective scene.

Applying the foregoing, for example, to the illustration in FIG. **5** which may be considered to be a map of the projection of the elements a golf hole on the reference plane in a direction normal thereto and either of the scenes shown in FIGS. **6** and **7**, it will be seen that the map of FIG. **5** clearly indicates that the trap **56** or **80** should be centered about a location approximately ten yards to the right of the Z axis and 70 yards out. In actuality, a number of points about the periphery of the trap can be ascertained and using a graph along the lines of that illustrated in FIG. **2** but with a greater number of yard lines, the actual location of the periphery of the trap may be easily ascertained at a number of points and graphed. Thereafter, the graph need only be applied to the photograph to ascertain whether the actual indication of the location of the trap or hazard is correctly illustrated. With reference to FIG. **6** for example, it will be seen that a front edge of the trap indication **68** is approximately at the 50 yard line whereas in actuality, the front edge of the trap **58** should be just slightly ahead of the 70 yard line to agree with the map. Thus, it is clear that the indication of the trap **68** should be removed and a corrected indication utilized.

With respect to FIG. **7**, it will be seen that the rear edge of the trap indication **104** is about at the 100 yard line whereas FIG. **5** indicates that the same should be at approximately the 75 yard line. So again, the indication **104** in FIG. **7** should be removed.

Then, using the information obtainable from the map, a new correct indication may be inserted using the graph, as at **108** in FIG. **8** which would correctly depict the location of either the trap **56** or **80** shown in FIGS. **3** and **4** to obtain the correct display.

As mentioned previously, this procedure is repeated for each scene with respect to what would be the Z axis for a shot taken from that particular zone. That is, as the measurement is made with respect to a line extending from the point in the zone from which the photograph is taken, to the cup and, of course, the position of such a line could very well be different for each zone on a particular hole.

## Correcting a Map

As mentioned previously, there are two possible sources of error in indication when untouched photographs are used in conjunction with a map spot projection system along the lines of that disclosed in the above-identified Russell et al. application. They are improper locationing of the projected ball spot on the projected scene due to changes in the terrain depicted in the scene and inconsistent indications as between the ball spot indication on the scene and the map spot indication on a map. The already described method is useful for eliminating both problems but may not be entirely necessary in those instances where an error of the first type is sufficiently small. In such a case, actual scenes that are uncorrected may be utilized with an appropriate correction made on the map of the golf hole used in conjunction with the map spot projection system.

A typical golf hole having uneven terrain is illustrated in FIG. **9** and is seen to include a terrain line,

generally designated **120** which illustrates the uneven nature of the terrain of the hole with respect to a reference plane **122**. It is to be noted that the reference plane **122** may be arbitrarily selected but generally is chosen so as to pass through the base of a flagstick **124** so that the cup of the hole will always lie in the reference plane.

A scene of the hole may be taken from a camera viewpoint **126** along the lines of those described in conjunction with the previous embodiment and in general, a camera located at the viewpoint **126** will be oriented in the same manner described previously.

The hole includes a trap, generally designated **128** which is located below the reference plane **122**. Additionally, the green on the hole is slanted toward the view point and as seen in FIG. **9** comprises that portion of the terrain line **120** located between the points **130** and **132**. As illustrated, a portion of the green is above the terrain line **120** while another portion is below the same with but a line segment of the green actually in the reference plane **122**.

Various lines as illustrated in FIG. **9** may be drawn between the periphery of the green **129** and the trap **128** so as to project the location of both on the reference plane **122**. As viewed in FIG. **9**, the location of the trap **128** on the reference plane extends between points **140** and **142** while the location of the green **129** on the reference plane **122** extends between points **144** and **146**.

It will be recalled from the foregoing general description of the mode of operation of the Russell computer that for any given distance, the projected spot is located on the screen with respect to a planar playing surface which may be considered for purposes of this example to be coextensive with the reference plane **122**. Thus, with reference to FIG. **9**, it will be seen that any shot hit essentially straightaway from the tee which may be assumed to be that point directly below the viewpoint **126**, a distance of between 80 and 126 yards will be projected to a location on the reference plane **122** within the bounds of the points **144** and **146**. That is, such a shot will appear to have landed on the green **129**.

Therefore, steps must be taken to eliminate any consistency between the ball spot indication and a map spot indication inasmuch as a normal map of the hole used in conjunction with the map spot projector would depict a point of termination short of the green **129** for all shots up to 90 yards in length and would indicate a point of termination beyond the green for all shots in excess of 110 yards in length. Accordingly, it is necessary to alter the map and the same has been done as illustrated in FIG. **10**. Specifically, the actual locations of the green **129** and the trap **128** are shown in solid lines but in preparing a map, the dotted line indications for the green **148** and the dotted line indication for the trap **150** would be used. The two dotted line indications **148** and **150** are arrived at by projecting from the viewpoint **26**, the peripheries of the trap **128** and green **129**, respectively, on the reference plane **122** and then using such points of projection to define the peripheries for purposes of preparing a map. As illustrated in FIG. **10**, two points **140** and **142** on the projection of the periphery of the trap **128** are illustrated as well as two points, **144** and **146** of the projection of the periphery of the green **129** are shown. By taking other sections, other points can be ascertained and the map redrawn to suit the prospective view provided by the unretouched photograph.

While this approach is generally satisfactory in those instances where there is not a great deal of deviation from a planar playing surface, undue deviation in such items as traps and greens can result in significant and unnatural elongation of the particular element involved particularly when the same straddles the reference plane as is the case with the green **129** illustrated in FIG. **9**. As viewed in FIG. **10**, the resulting map illustrating the green as at **148** would have a relatively elongated green and were the same to be elongated much beyond that illustrated in FIG. **10**, the same would be so completely unnatural as to be substantially unusable.

Thus, the second method according to the invention can be used with success if some discretion is chosen in selecting the holes to be photographed. Furthermore, the method illustrated in FIGS. **9** and **10** may be used in conjunction with that as described in FIGS. **2–8**, inclusive. That is, in some cases where it is not totally practical to completely move the indicated location of a hazard or a landmark by photo-retouching, the same may be partly removed as permissible and then the map altered to finally true up the indicated location and the actual location according to the second embodiment described. One such case would be where a trap in front of the green is elevated with respect to a reference plane passing through the cup. While not shown therein, an understanding of FIG. **4** will lead to the conclusion that a trap elevated above a reference plane coinciding with a green and located just in front of the green would have its projection on the reference plane encompassing part or all of the green. Obviously, in such a case, the trap could not be deleted in the photograph and reinstated on the green.

In many cases, the second embodiment of the invention may be preferable to the first. This is particularly true where the indoor golf game includes a map spot projecting system such as that disclosed in the above-identified application of Russell and Feeney wherein the map is projected on the screen. For the reasons set forth in the Russell and Feeney application, each map projected on the screen will be unique to the particular scene associated therewith and as a result, some deviation from one projected map to another, even though for the same hole, may be accommodated without the golfer's knowledge due to the fact that only one map is projected on the screen at any given time. Thus, for a zone to the left of the green, one map maybe projected with the associated scene while, from another zone to the right of the green, a totally different but somewhat similar map may be projected for the scene from that zone. And the fact that the projected maps are changed with each scene will effectively preclude a golfer from noting that the maps are different unless the differences are drastic, in which case, the differences can be reduced to an acceptable level with the remainder of the required change being accomplished through photo-retouching.

Of course, should a map spot projecting system of the type disclosed in the Russell and Baldwin application be used, it would only be practical to have but a single map for a hole. In such a case, the maps for each

zone may be compared and the map most nearly fitting the scene depiction of all zones selected as the map used in playing the game.

### Changing the Reference Plane as the Green is Approached

In some cases, the altering of scenes according to the first embodiment of the invention requires such drastic retouching that the retouching is obvious when the scene is displayed. Similarly, in some instances, when the second embodiment of the invention is practiced, correction of the map results in unnatural elongation of certain landmarks or elements of a golf hole such as the green. When either of the foregoing problems occurs, either embodiment may be modified by changing the reference plane as the landmark is approached. Since the foregoing problems are more likely to be encountered around the green of a golf hole, the following discussion will utilize the green area in detailing the modification of the methods. However, it is to be understood that the problems involved may find applicability at non-green area locations on a hole such as around fairway traps.

The modification may best be understood with reference to FIGS. **11** and **12**. As mentioned previously, normally, the camera height will be maintained constant either with respect to the first selected reference plane or the playing surface of the course. Accordingly, a line **160** in FIG. **11** represents the camera height level while a line **162** represents the reference plane. The terrain line is indicated at **164** and the area between points **166** and **168** thereon defines a sand trap in front of a green defined by points **170** and **172** on the terrain line **164**.

A line **174** depicts a plane encompassing the periphery of the green while a line **176** depicts a plane encompassing the periphery of the trap. A line **178** defines an average plane between the planes represented by the lines **174** and **176**.

Parallel to the average plane represented by line **178** is a line **180** representing a plane parallel to the average plane and which is located above the average plane, according to one embodiment, a distance of 16 feet. The line **180** intersects the line **160** at a point **182** and, if the hole is chosen according to the criteria mentioned previously, the point of intersection **182** will be a distance of 100 or more yards from the green.

In practicing the modification according to the method, for all points nearer to the tee than the point **182**, the camera location is on line **160** (assuming that the camera height is to be maintained constant with respect to the reference plane and not to the playing surface) photographs are taken from each zone according to either of the foregoing methods. However, when photographs are to be taken from locations closer to the green than the point **182**, the camera is then located on the line **180**.

Since most golf greens are pitched towards the fairway (that is, the rear edge of the green is higher than the front edge of the green), and since most traps are similarly pitched, the location of the camera for each shot on the line **180** will result in progressive elevation of the camera above the green as the cup is approached.

The effect of the foregoing may best be understood through a consideration of FIG. **12** which again shows a terrain line **164** and a trap defined by points **166** and **168** thereon. Similarly, the green is defined by points **170** and **172** on the terrain line. Also shown is the green plane **174**, the trap plane **176** and the average plane **178** with the camera level line **180** being parallel to the latter.

FIG. **12** also shows two viewpoints, **184** and **186** on the camera line **180**. Projection from the viewpoint **184**, which is further from the cup than the viewpoint **186**, shows the apparent location of the trap between points **188** and **190** represented by small circles on the average plane **178**. The location of the front edge of the green as viewed from the viewpoint **184** is represented by a circle designated **192**.

It will be observed that there is substantial overlap of the apparent location of the trap on the average plane **178** and the actual location of the trap on the terrain line so that the margin for inconsistent indications is markedly reduced from that that would be present if only the single reference plane mentioned previously were to be used. The disparity may be observed by comparing either FIGS. **3** or **4** with FIG. **12**. Such a comparison will clearly indicate the superiority of indication achieved through the modification of either method.

Furthermore, the margin for inconsistent indications is further decreased as one approaches the green according to the modification of the methods when the location of the front edge of the green and the trap is in perspective to the viewpoint **186**, significantly more overlap is obtained. The projections with respect to viewpoint **186** on the average plane **178** are designated by squares with the squares **194** and **196** illustrating the projection of the trap and the square **198** illustrating the projection of the front edge of the green.

Quite frequently, the small deviation from complete overlap can be eliminated almost wholly by map alteration. However, some cases arise wherein the deviations from complete overlap may be eliminated by retouching alone, or for that matter, by both map alteration and scene retouching.

The modification to either method has been described in conjunction with a single trap located in front of the green for simplicity of illustration. In practice, however, it is found most desirable to utilize the same in conjunction with traps to the side of the green or flanking the green.

## SUMMARY

From the foregoing it will be appreciated that the various embodiments of the method coupled with the possible modifications thereof provides a way by which perspective view scenes of a golf hole and/or a map of a golf hole to be used in an indoor golf game can be corrected to provide an accurate indication of the results of a shot to a golfer playing an indoor game. In essence, the same involves the adaptation of a scene and/or a map to a desired hypothetical playing surface, herein the reference plane. Of course, if the computation and indication system of the indoor game were to consider that the playing surface was in a continuous geometrical form other than a plane, the principles of the invention would be equally applicable thereto. For example,

if the playing surface were to be considered to be in the form of a large diameter cylinder, and a computer appropriately programmed for such a playing surface, both embodiments of the method could be practiced. In the case of the scene alteration, the graph used in retouching would have a different form insofar as the azimuth lines are concerned while the maps would be formed by projecting the boundaries of the landmarks in a manner generally similar to that mentioned above.

It will be appreciated that the scenes and/or maps resulting from the performance of the various embodiments of the methods are quite superior to those heretofore known insofar as they provide both increased realism in the depiction of the hole through the use of photographs of an actual hole as well as providing increased accuracy and realism in indication, both factors heretofore obtainable only singly.

We claim:

1. A method of providing a perspective scene of a golf hole for use in an indoor golf game having a ball flight computer programmed to base computation on a hypothetical playing surface of a predetermined geometrical configuration and comprising the steps of:
   a. taking a photograph of at least a portion of a hole on an actual golf course;
   b. determining the location of at least one landmark on said portion of the golf hole on said predetermined geometrical configuration as representing a hypothetical, desired playing surface; and
   c. relocating the landmark in the photograph to be coextensive therein with the location of the landmark on the hypothetical playing surface as the latter would appear in the photograph by photographic retouching.

2. The method of claim 1 wherein step (b) is performed with a map of the portion of the golf hole depicting the hole in said predetermined and geometrical configuration and step (c) is performed with the use of a graph showing both azimuth and range parameters of an indicator operated by the computer employed in the indoor golf game.

3. A method according to claim 2 wherein the predetermined geometrical configuration is a plane and a photograph is taken with a camera having its optical axis parallel to the hypothetical, desired playing surface.

4. A method according to claim 1 especially adapted for use with an indoor golf game further including a map of each hole on which an indicator operated by the computer indicates the point of termination of each shot, said method further including forming a map of the golf hole using said predetermined geometric configuration as the base of the map so that the location of the landmark on the map appears at the location on said predetermined geometrical configuration as viewed from the point at which step (a) is performed.

5. A method of providing at least one of a perspective scene and a map of a golf hole for use in an indoor golf game employing a computing and indicating system which bases ball flight computation on an assumed, hypothetical playing surface of a predetermined geometrical configuration and which indicates the computed point of termination of a shot on at least the perspective scene of the hole being played, said method comprising the steps of:
   a. taking a photograph of at least a portion of a hole on an actual golf course;
   b. determining the location of at least one landmark appearing in the photograph on the hypothetical playing surface by projecting the same thereto with respect to a predetermined point; and
   c. altering at least one of the perspective scene and the map to illustrate the landmark in its projected position on the hypothetical playing surface.

6. A method according to claim 5 wherein the scene is altered.

7. A method according to claim 5 wherein the map is altered.

8. A method according to claim 5 wherein both the scene and the map are altered.

9. A method according to claim 5 wherein the portion of the golf hole photographed includes a green and at least one trap adjacent thereto, and said photograph is taken with its optical axis parallel to a plane comprising the average plane between two planes, one approximately encompassing the plane of the periphery of the green and the other approximately encompassing the periphery of the trap.

10. A method according to claim 9 wherein the scene is altered.

11. A method according to claim 9 wherein the map is altered.

12. A method according to claim 9 wherein both the scene and the map are altered.

13. A method of providing a map of a golf hole for use in an indoor golf game employing a computing and indicating system which bases ball flight computation on an assumed, hypothetical playing surface of a predetermined geometrical configuration and which indicates the computed point of termination of a shot on both a prespective scene of the hole being played and a map of the hole being played, the method comprising the steps of:
   a. taking a photograph of at least a portion of a hole on an actual golf course;
   b. determining the location of at least one landmark appearing in the photograph on the hypothetical playing surface by projecting the same thereto with respect to the point at which the photograph is taken; and
   c. altering the map by locating the landmark at its projected position on the hypothetical playing surface.

14. A method according to claim 13 wherein the hypothetical playing surface is defined by a plane selected, as nearly as possible, to coincide with the actual playing surface of the hole.

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