Oct. 17, 1967

E. H. SMITH

3,347,398

BACKHOE COMBINATION

Filed Jan. 28, 1966

3 Sheets-Sheet 1

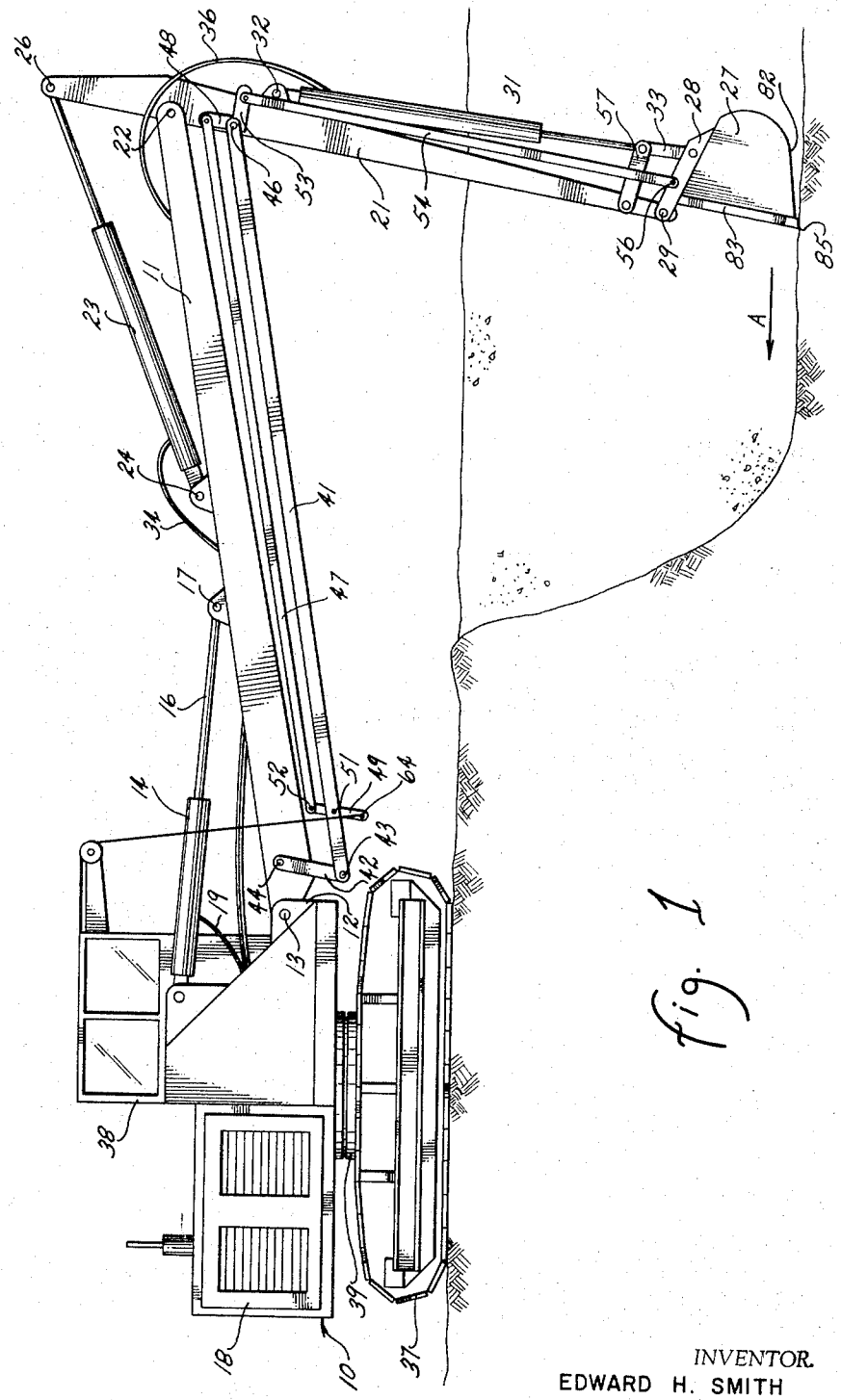


Fig. 1

INVENTOR.
EDWARD H. SMITH

BY

John J. McLaughlin

ATTORNEY

Oct. 17, 1967 E. H. SMITH 3,347,398

BACKHOE COMBINATION

Filed Jan. 28, 1966 3 Sheets-Sheet 2

fig. 2

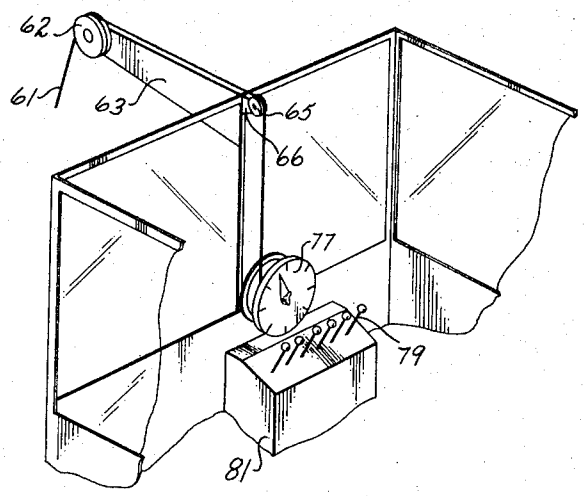
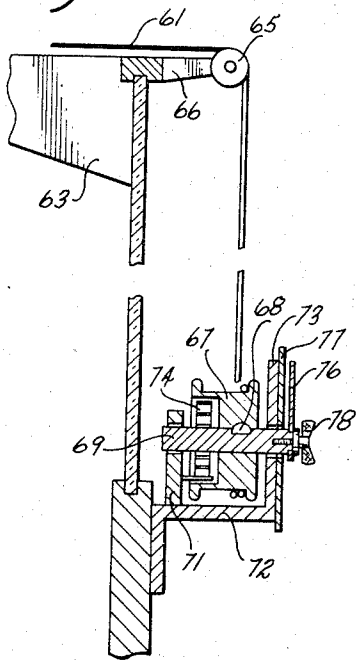


fig. 3



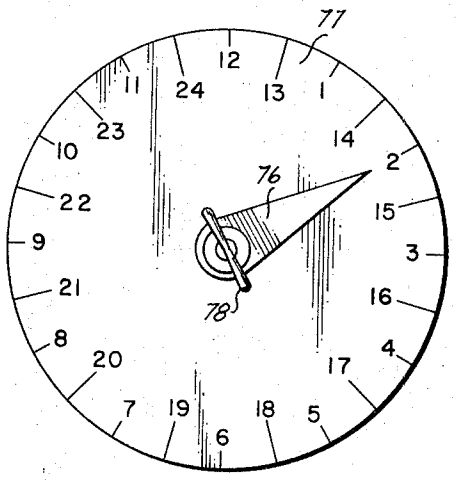


fig. 6

INVENTOR.
EDWARD H. SMITH
BY
John J. McLaughlin
ATTORNEY

Oct. 17, 1967 E. H. SMITH 3,347,398

BACKHOE COMBINATION

Filed Jan. 28, 1966 3 Sheets-Sheet 3

fig. 4

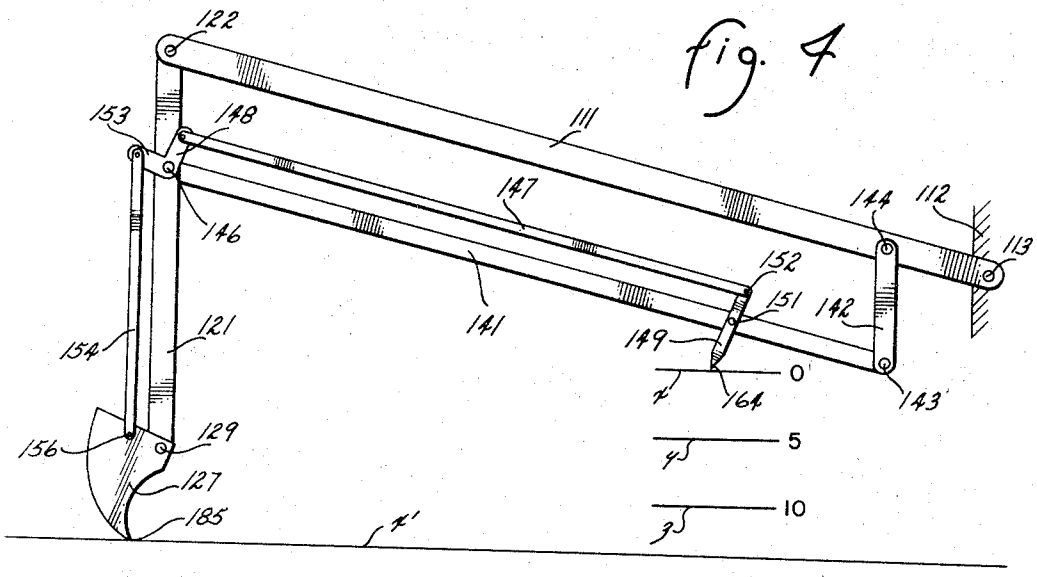
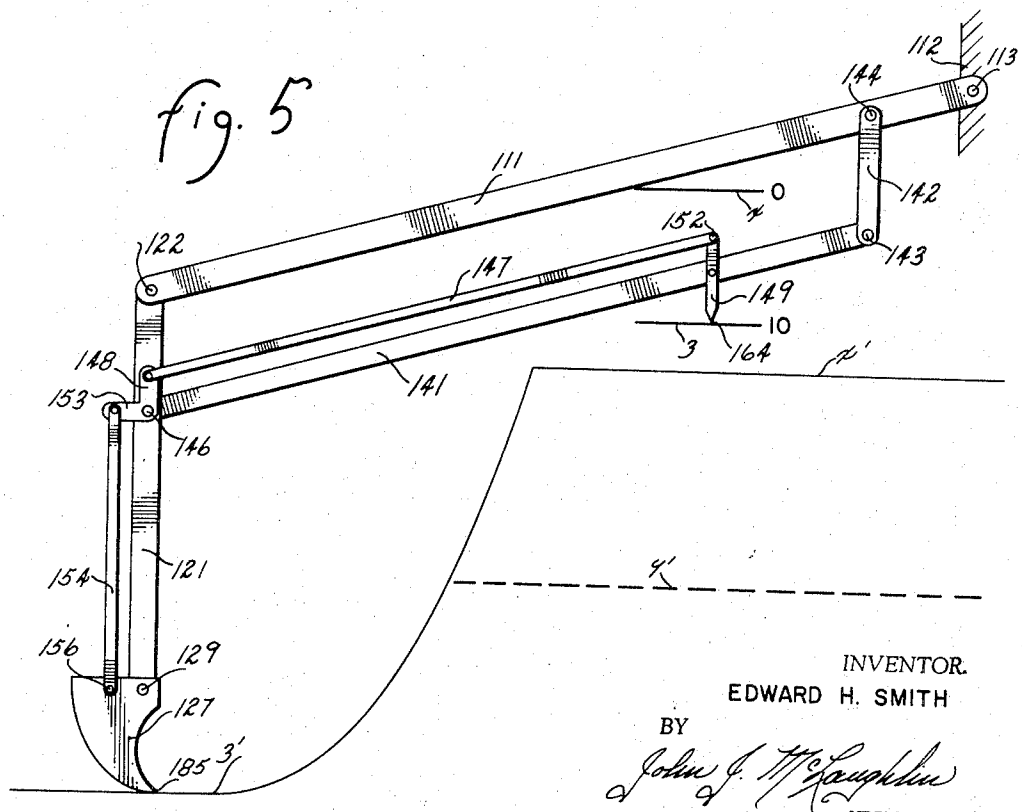


fig. 5



INVENTOR.
EDWARD H. SMITH
BY
John J. McLaughlin
ATTORNEY

United States Patent Office 3,347,398
Patented Oct. 17, 1967

3,347,398

BACKHOE COMBINATION

Edward H. Smith, 110 E. Manhatton,
Tempe, Ariz. 85281

Filed Jan. 28, 1966, Ser. No. 523,720
4 Claims. (Cl. 214—138)

ABSTRACT OF THE DISCLOSURE

A backhoe machine provided with an indicator visible to the operator for measuring the bucket position when it is hidden from the operator's view. The indicator comprises three indicator rods which, with a bell crank lever pivoted to the crowd, form two pantographs, and indicator means responsive to the position of the digging edge of the curl.

My invention relates to an improved backhoe combination. It relates more in particular to a backhoe combination by means of which the bottom level of an excavation can be accurately controlled by the operator even though he may not be in a position to see the bucket or curl which is operating to dig and remove earth.

The continuing increase in the popularity of backhoes is due not only to their versatility but also to the fact that they are the only earth-moving or earth-digging instrument except the trencher which can dig and shape excavations, the bottoms of which are substantially below the level on which the tractor carrying the equipment is resting. Some modern backhoes can excavate 25 to 30 feet below the level of the vehicle supporting the boom assembly. The basic parts of all backhoes are identical, although they may be operated by hydraulic power, by a system of cables or by means of other mechanical expedients. My invention is not concerned with the manner in which the bucket or curl is manipulated to a position for digging and removing earth. It is concerned with accurate control of the curl, particularly as to depth, whatever the manner of adjustment and operation of the curl may be. This control is maintained entirely by the operator and depends on the provision of indicating equipment which then becomes an integral part of the structure of the backhoe itself.

In general, all backhoes of the type to which my invention relates employ a vehicle such as a tractor to which a boom is supported, with its unpivoted end adjustable vertically. The boom carries a pivoted arm, commonly called a crowd, and a bucket or curl is pivoted on the bottom end of the crowd. Means are provided for operating the boom, the crowd and the curl separately or together. The entire assembly with the framework supporting the boom is generally rotatable around a vertical axis to deposit earth at a position removed from the excavation when the operating parts have been placed in a position to remove the earth-filled curl from the excavation. It is the bottom or drigging edge of the curl which is of importance in determining the depth of the excavation. The depth of the excavation may be uniform, or it may slant such as will be the case if a sewer excavation or the like is being dug; and the level must be controlled regardless of the unevenness of the ground on which the vehicle is supported.

The principal object of the present invention is the provision of an improved backhoe, by means of which the operator can control accurately the depth of an excavation even though he may not be able to see the bucket or curl which is actually the instrument which controls such depth.

Another object of the invention is the provision of a backhoe combination as called for in the preceding object in which the controlled depth may have no fixed relation

to the level of the ground on which the backhoe vehicle is resting.

A further object is the provision of means visible to an operator for simultaneously showing the digging attitude of the curl and the depth at which it is digging.

Other specific objects and features of the invention will be apparent from the following detailed description, taken with the accompanying drawings wherein:

FIG. 1 is an elevational view showing one form of a backhoe embodying the features of the present invention and indicating the manner in which it may be used to dig an excavation substantially lower than the ground level on which the vehicle is resting;

FIG. 2 is a fragmentary perspective view showing the inside of a cab of a backhoe embodying the features of the present invention;

FIG. 3 is a somewhat enlarged fragmentary sectional view taken along the line 3—3 of FIG. 2;

FIGS. 4 and 5 are schematic views with parts corresponding to parts employed in an actual commercial structure and illustrating the manner in which the system of the present invention functions; and

FIG. 6 is an enlarged elevational view showing one suitable arrangement of the indicator dial showing the digging depth.

The drag hoe embodying the features of the invention as shown in the drawings is illustrative, but its basic structure, excluding the features of the present invention is not identical with any commercial backhoe of which I am aware. I may employ as the basic structure, however, any of the conventional backhoes of commerce manufactured by such companies as International Harvester, Insley Manufacturing Corporation, John Deere, the Schield Division of the Koehring Company, Hein-Werner, the Case Company, or the Gardner-Denver Company. Units such as manufactured by these companies may be controlled in various ways and illustrative of backhoes to which my invention may be applied is the C–350 Bantam, a cable-operated drag hoe manufactured by the Koehring Company, the Hein-Werner model No. C–12, the Clark model of backhoe produced by the Gardner-Denver Company, Insley's model HC–560, and the Series 93 and Series 95 models manufactured by John Deere. These models are mentioned illustratively to show that my invention may be applied to practically any of the usual commercial units embodying the drag hoe principle with little or no modification.

Referring now to the drawings, a trackless self-propelled vehicle indicated generally by the reference character **10** has a boom **11** pivoted to its frame superstructure **12** by a suitable pivot **13** so that the free end of the boom **11** may be raised and lowered by conventional means here shown as embodying a cylinder **14** pivoted to the frame superstructure and a piston **16** pivoted to the boom **11** at **17**. A housing **18** is provided for power units not shown, but normally a source of hydraulic power in the form of a compressor for each cylinder and piston combination is used by most companies, although other methods of providing hydraulic fluid under pressure may be used. In the drawing, I show a hydraulic hose **19** extending through the cylinder **14** by means of which hydraulic fluid may be forced into or withdrawn from the cylinder **14**. It should be remembered that the cylinder and piston combination is power-operated in either direction to raise or lower the boom, but since my invention is not primarily concerned with the manner in which this is accomplished, and the mechanism is well known, I have not illustrated the details of this cylinder piston and piston-rod combination.

A beam **21**, commonly called the "crowd" in the backhoe art, is pivoted at **22** intermediate its ends to the outer end of the boom **11**. The hydraulic cylinder and pis-

ton combination which, for convenience, I shall refer to as a unit by the expression "hydraulic jack" and indicated by the reference character **23** is pivoted at **24** to the boom and at **26** to the top short span of the crowd **21**. A bucket or curl **27** has an upwardly projecting frame portion **28** at its rear edge (upper edge in the position shown in FIG. 1) and an upper projecting portion of the curl frame portion **28** is pivoted at **29** to the bottom end of the crowd **21**. A jack **31** is pivoted at its upper end at **32** to the crowd and at its bottom end to a rearwardly projecting frame portion **33**. It will be seen from what has been described that the boom **11** can be raised or lowered about its pivot **13** by the action of the cylinder **14** and piston and piston-rod **16**; that the crowd can be pivoted about its pivot **22** through the action of jack **23**, so that the curl **27** can be pivoted around the pivot **29** by the action of the jack **31**. A hydraulic line **34** delivers fluid to the jack **23**, another hydraulic line **36** delivers fluid to the jack **31**. These portions of the boom assembly are conventional in function and in part conventional in shape. In actual practice, more sophisticated shapes commonly used in the industry may be employed for all of these units.

Continuing with the conventional aspects of the backhoe shown in the drawings, the entire backhoe is propelled on tracks **37** in a conventional manner by an operator occupying a suitable position in a cab **38**. A turn-table structure **39** operated by suitable power controls (not shown) permits the operator to turn the entire assembly supported by the turntable **39** when the boom assembly has been actuated to remove an earth-laden curl entirely free from the excavation in which it is operating to thereby deposit the earth either on the ground near the excavation or in a waiting vehicle.

Even though the operator's position in the cab **38** is elevated, it is very seldom that an operator can see sufficiently down into the excavation to determine what he is doing and it is particularly difficult for him to tell the depth at which he is digging, even though stakes and level lines may be provided, and a helper may be stationed near the excavation to assist the operator in guiding the curl as it is moved in the direction shown by the arrow *a* in FIG. 1. It should be remembered that in digging, to control the level of the bottom of the excavation, the digging edge of the curl must be dragged in a horizontal direction as indicated by the arrow, and the curl rotated to pick up a load of earth only when the actual leveling and digging operation for a given "bite" has been completed. With the present invention, however, even without the assistance of an operator or any guidelines, the operator can finish an excavation to a desired level, whether horizontal or slanting, even though he cannot see the curl clearly as he is operating it. My invention depends on the utilization of certain principles, and a combination structure embodying these principles will now be described.

A primary indicator control rod **41** is pivoted at its inner end to an arm **42** by a pivot **43**, the arm **42** being pivoted to the boom **11** at **44**. At its opposite end, the primary indicator control rod **41** is pivoted to the crowd by a pivot **46**. The connections to the various pivots should be so constructed that no lost motion will occur, and the primary indicator control rod **41**, being parallel with the axis of the boom **11**, provides with the boom, the arm **41** and the portion of the crowd between the pivots **22** and **46** a pantograph-like structure. This structure can be used to indicate and control the position of the pivot between the crowd and boom, for example. More sophisticated controls and indicators are necessary because of the movement of the crowd and curl, and these are provided as will be explained.

A secondary indicator control rod **47** is parallel to the control rod **41** and is mounted at one end to an arm **48** of a bell crank lever which is pivoted on the pivot **46**, which is the same pivot on which the arm **41** is supported. At the opposite end of the secondary indicator control rod **47** there is an arm **49** pivoted intermediate its ends at **41** to the primary control rod **41**. The secondary indicator control rod **47** is pivoted at **52** to a top end of the arm **49**. The second arm **53** of the bell crank lever pivoted at **46** is pivoted to a tertiary indicator control rod **54** which is pivoted at its bottom end at **56** to the curl **27**. It will be noted that the pivot **56** is below the pivot **29** which joins the curl to the crowd **21**. It will be noted also that the functional axis of the crowd is between the pivot **22** and pivot **29** and that the tertiary indicator control rod **54** is parallel to the functional axis of the crowd and forms a pantograph-like assembly which, as will be explained, corrects for the position of the leading edge of the curl caused by rotating it about the pivot **29**. It may be noted at this point that the arm **57** acts as a strengthening and reinforcing member, and does not participate in the control and indicator function.

At this point, it may be well to explain that if we were not concerned with the movement of the curl **27**, the bottom of the arm **42** could function to operate a control to show the position of the bottom end of the curl **21**. By the utilization of the rod **54**, however, a correction is made for any turning action of the curl about the pivot **29**, so that the bottom end of the arm **49** now becomes the salient indicating portion of the mechanism and it is from the bottom of the arm **49** that the indicating mechanism observable by the operator is controlled.

Looking at FIGS. 2 and 3, a cable **61** is trained over a sheave **62** supported by an arm **63** immediately above and in front of the operator's position. The cable **61** has its bottom end secured at **64** to the arm **49**. From the sheave **63** the cable extends over a sheave **65** mounted on arm **66**. From sheave **65** the cable **63** extends down to a capstan **67** around which it extends, the capstan **67** being secured by means of a Woodruff key **68** to a rod **69** which is rotatably supported in an upper projection **71** from a frame **72** which also carries an integral extension **73** also rotatably supporting the rod **69**. A coil spring **74** biases the capstan **67** and its supporting rod or fulcrum **69** in a direction to rotate the capstan to the left, at which point an indicator **76** will show a low number such as zero on a dial **77**. Any movement which lowers the position of the pivot **64** coincident with the bottom end of the arm **49**, however, will cause the capstan **67** to rotate in a clockwise direction, causing the pointer **76** to indicate a larger number on the dial **77** corresponding to greater depth of the curl. It should be borne in mind that the indicating numbers on the dial **77** may show absolute depth, or they may show relative depth, depending upon circumstances and design. Thus, for example, the design may be such that the capstan will make two complete revolutions if the curl is dropped to the lowermost position capable in the design of the backhoe on which the indicating mechanism is placed. In this case, the dial **77** as shown in FIG. 6 would have two series of numbers in which any depth from zero to 24 feet could be read by the operator from his work station.

Frequently, the ground in which the excavation is made will have a slanting top surface, and it is then a common practice to show a level position by a cord supported on stakes driven into the ground. Alternatively, for some reason, equipment may be operating from a position which is somewhat lower than the terrain generally and it is necessary to make a correction for depth. I therefore secure the pointer **76** releasably to the rod or pivot pin **69** by means of a thumb nut **78** so that the operator can adjust the indicator **76** by a higher or lower figure so that all he needs to do is read the proper depth on the scale **77** as he operates the backhoe. It will be noted that the scale **77** is placed immediately in front of the operator so that his control handles generally indicated by the reference character **79** projecting from the console **81** can be handled by the operator without taking his eyes off any significantly important part of his work.

It should be noted that as the curl **27** is rotated about the pivot **29** in a clockwise direction looking at FIG. 1, the bell crank lever including the arm **53** and arm **48** as well as the arm **49** will also be rotated in a clockwise direction, and this will indicate that the depth at which the curl is operating has been reduced. Those skilled in the art understand however, that if the rounded portion **82** of the bucket or curl **27** comes into contact with the bottom of the excavation, no digging action can occur. In determining depth, therefore, the operator is interested in the position of the curl **27** with respect to its pivot **29**, and that this position is important and must be known even if he cannot see the curl. Controls are so arranged, however, that the top frame **83** of the curl is generally parallel with the arm **49** so that the operator can always tell the approximate attitude of the curl by observing the position of the arm **49**. He can also observe the position of the arm **48**, it being obvious that both of these arms are generally in the direction in which he will be directing his attention during a digging operation.

FIGS. 4 and 5 are schematic views showing generally the parts disclosed and described in connection with FIG. 1 but in somewhat simplified form. I have employed the same reference characters in FIGS. 4 and 5 that were used in FIG. 1 with, however, the prefix 1 to indicate slight modification. If we assume that the lines *x*, *y*, and *z* are applied on a flat or plane surface, they can be considered as identifying the lines which the bottom of the lever **149** will define when the point of the curl **127** is moving along a line corresponding to zero depth, five feet depth, and ten feet depth respectively. In FIG. 4, the ground level assumed to be at grade, is represented by the line *x'* so that if the point of the curl moves along *x'*, the point of the arm **149** will move along the line *x*. In FIG. 5, the line *z'* indicates ten foot depth, and the point of the arm **149** will move along the *z* indicating ten-foot depth. A dotted line *y'* indicates the level at which the front edge of the curl would move if five-foot depth were the level to which the excavation would be made.

The lines indicating level of excavation shown in FIGS. 4 and 5 are, of course, illustrative, but they further bring out the fact that instead of a dial **77** with a pointer **76**, the depth at which digging occurs can be shown on a linear chart if desired. In general, however, I have not employed a chart of this kind because, a rule, it will utilize considerable space and may obscure to some extent the view of the operator. It is, of course, obvious also that many other types of indicators may be employed, many of which are well known, such as electrical indicators in which the movement of the point **164** would increase or decrease the resistance in a circuit with an electrical meter showing the depth or position of the point of the curl.

It is very important that those skilled in the art to which the present invention relates understand that the present invention may take many forms without departing from the spirit and scope of the invention. I have already pointed out that the vehicle, boom, crowd and curl have been simplified for purpose of illustration, and employ hydraulic driver of a particular form to simplify illustration and description. This same convention has been followed, even to a more marked degree in illustrating the various connections between the digging tip **85** of the curl and the indicator utilized to show depth. Those skilled in the art are aware of the fact that backhoes must be constructed to withstand rough usage, so that the provision of the various control rods, arms and levers forming a part of the control mechanism will not normally be in positions to be injured during normal operation as they would be if placed exactly as shown in the drawings. Rather, these working parts of the control assembly would be housed within the boom and crowd as the operating mechanism is now in most commercial backhoes.

With further reference to the control and indicator assembly of the present invention, it may be stated that in effect I use a pantograph on a pantograph. While most buckets or curls of backhoes are pivoted to facilitate scooping action to fill them with excavated earth, some are unpivoted. In such a case, the point **43**, or even the point **46**, could be an indicator for the position of the toothed digging point **85** of the bucket or curl. The entire arm **42**, in this case, would also occupy a fixed position with respect to the curl—with arm **42** parallel with the top rim **86** of the curl for example—so that the operator will know for a certainty that the digging tip **85** is in digging position.

Because the curl **27** is pivoted at **29**, however, in the embodiment of the invention as disclosed, rotation of the curl about its pivot moves the arm **49** through the linkage shown, but the arm **42** is not moved correspondingly. Arm **53** of the bell crank lever is moved, however, and this in turn changes the angle of arm **48** as arm **49** changes position. Thus, in the embodiment shown, arm **48** could also be employed as an indicator.

Attention is also called to the fact that the rods **41**, **47** and **54** function both in compression and tension, as in effect do the hydraulic jacks here shown to actuate the boom, crowd and curl. Those skilled in the art are aware, however, that just as a series of cables, all working in tension, and with pairs of cables opposing each other, are used to move the boom, crowd and curl, so also may such a cable system—or any other usual mechanical, hydraulic or electrical system—be used for actuating the level indicating controls. Thus, functionally either lever **49** or the bell crank lever can be considered as parts of wheels or sheaves in a cable system, with indicating means associated with them. The correspondence of the types of movement transmission systems described is, of course, well known in the art as related to boom, crowd and curl operation.

I have shown and described a specific embodiment of the invention so that those skilled in the art may understand the manner of practicing the same, but the scope of the invention is defined by the claims.

I claim:

1. In a backhoe with a boom pivoted to a vehicle frame, a crowd pivoted to the boom and a curl pivoted to the crowd and means for manipulating said parts to move said curl in an excavation digging action,

(a) a primary indicator rod having one end pivoted to the crowd, an arm pivoted to an opposite end of said rod and to the boom, said rod, arm and contiguous portions of the crowd and boom defining a pantograph,

(b) a second indicator rod, an indicator arm pivoted intermediate its ends to the primary indicator rod with an indicator point at one end and another end pivoted to one end of said second indicator rod, and a bell crank lever pivoted to the crowd with one arm thereof pivoted to another end of said second indicator rod, indicator arm, one arm of the bell crank lever and contiguous portions of the primary and secondary indicator rods forming a second pantograph,

(c) a third indicator rod pivoted to a second arm of the bell crank lever and curl at a position spaced from its pivot, and

(d) indicator means responsive to the position of said indicator point for showing the depth of a digging edge of said curl in an excavation.

2. A backhoe combination as defined in claim **1** wherein said indicator means includes,

(e) a capstan spring biased to rotate in a counter-clockwise direction,

(f) a pointer covered by the capstan,

(g) a dial showing depth numerals around its periphery increasing in value in a clockwise direction, and

(h) a cable having one end secured to said indicator point and another end to the capstan and coiled

around the same lowering of the curl functioning to rotate the capstan in a clockwise direction.

3. A backhoe combination as defined in claim 2 wherein said indicator means includes,

(i) and means for adjusting the position of the pointer on the capstan to correct the level indicator because of a grade differential where the backhoe is supported.

4. A backhoe combination as defined in claim 1 wherein said indicator means includes a panel with a series of parallel horizontal lines indicating depth and along which said indicator point may be caused to travel in the general direction of said lines at a depth indicated thereby.

References Cited

UNITED STATES PATENTS

2,178,265	10/1939	Peterson	37—63
2,704,047	3/1955	Lushenko	116—124
3,033,394	5/1962	Kashergen	214—138
3,187,913	6/1965	Strader et al.	214—761

FOREIGN PATENTS

556,131	9/1943	Great Britain.

HUGO O. SCHULZ, *Primary Examiner.*