

United States Patent

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[54] LAYING OF CONCRETE KERBS, HAUNCHES AND THE LIKE

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[51] Int. Cl.....E01c 19/48

[58] Field of Search.....94/46-44, 45

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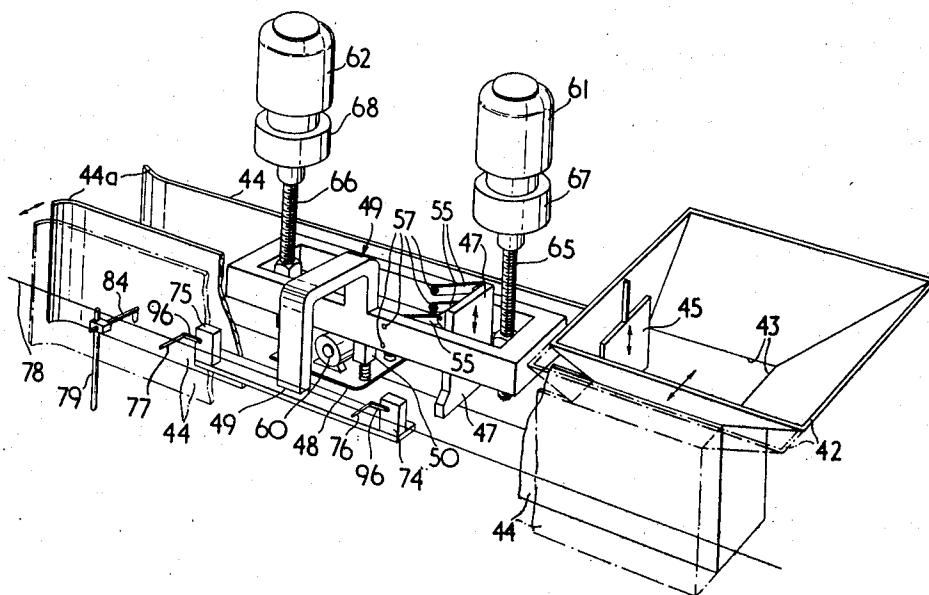
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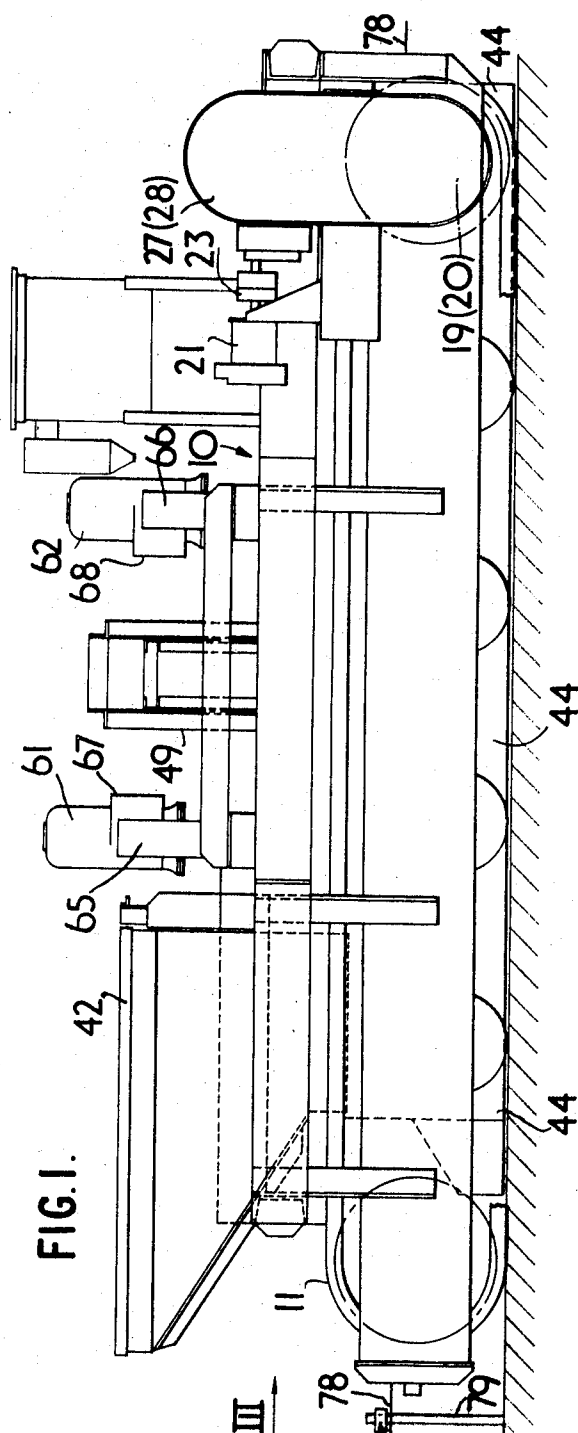
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ABSTRACT

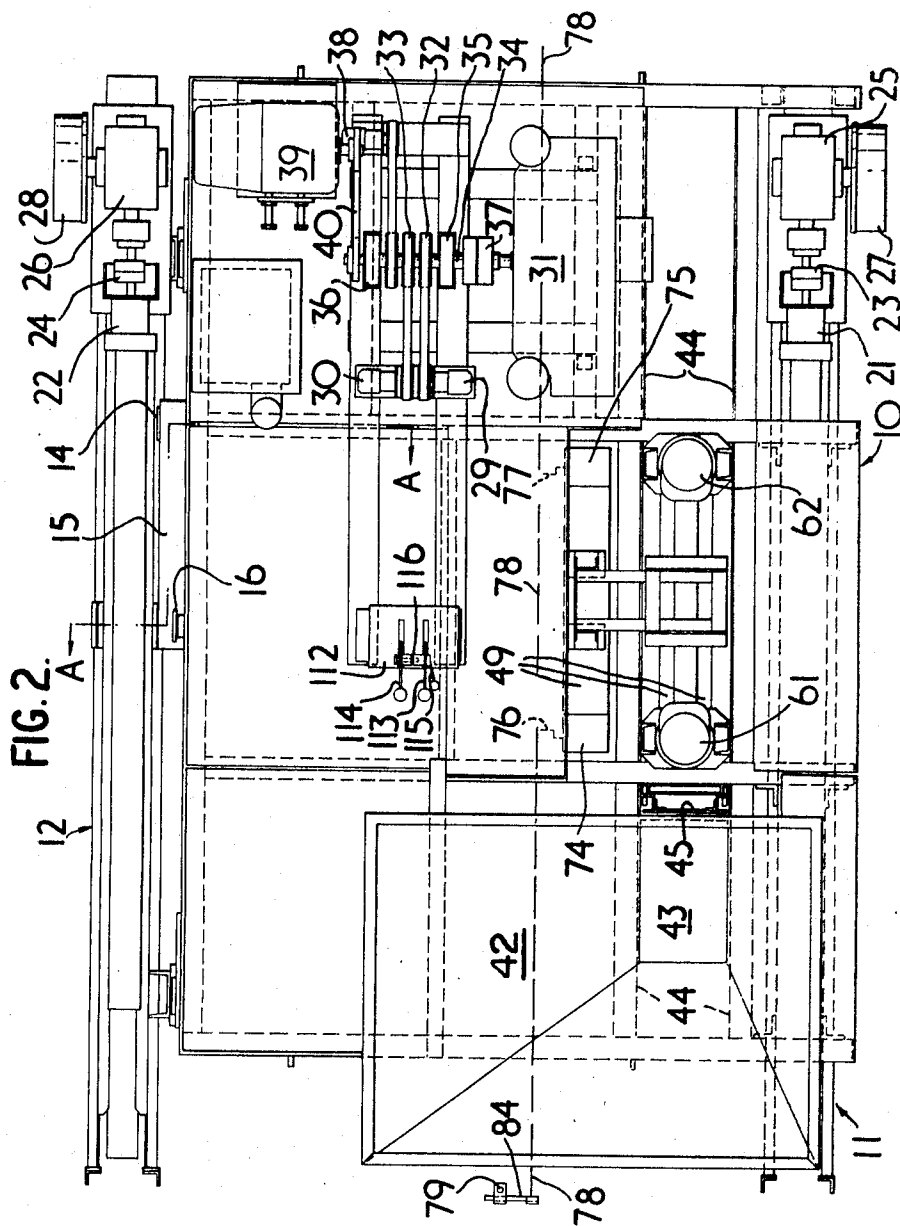
Concrete is laid to a surface defined by a datum wire extending e.g. over rough ground by a machine including a mobile carriage with a concrete hopper feeding concrete between slip forms in a controlled fashion using a gate vertically movable in dependence on the movement of sensing devices touching the wire. Smoothing devices one mounted on a subframe of the machine for vertical movement also in dependence on the sensing devices.

18 Claims, 17 Drawing Figures





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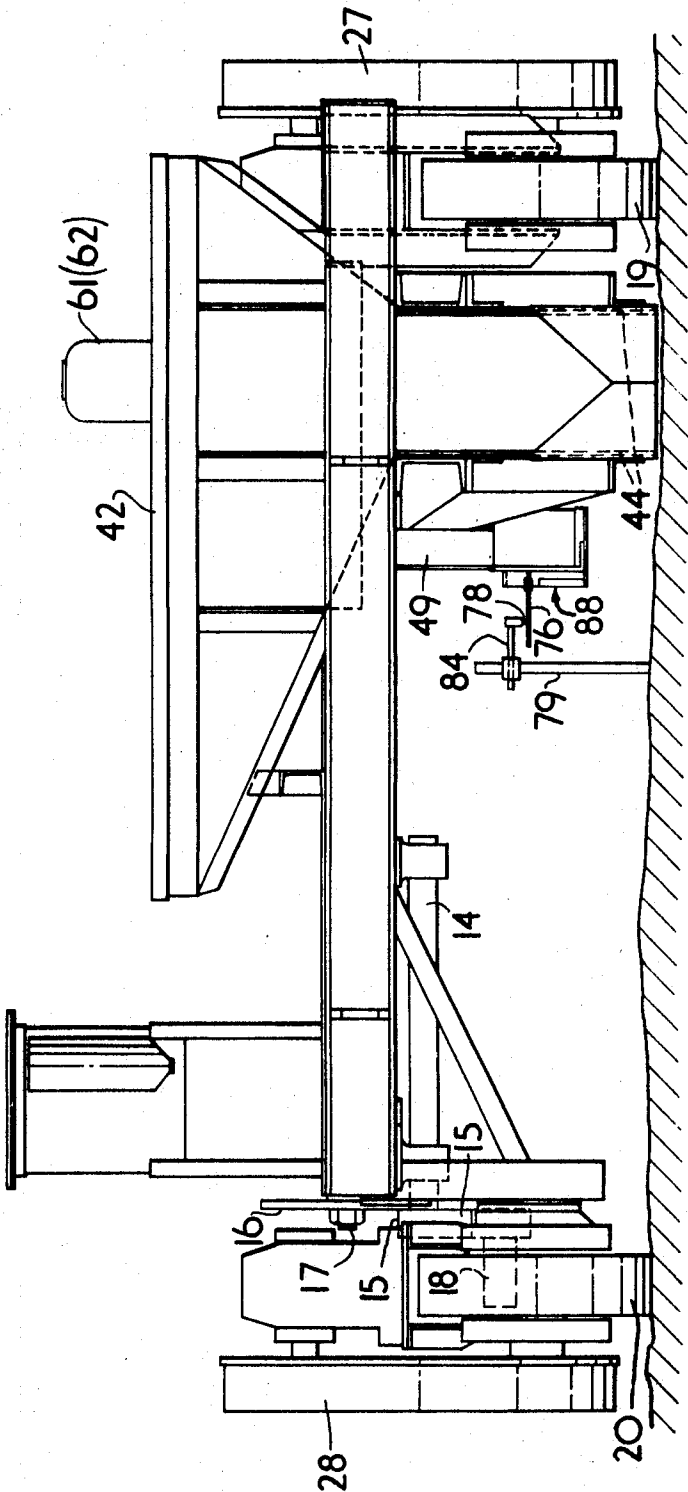
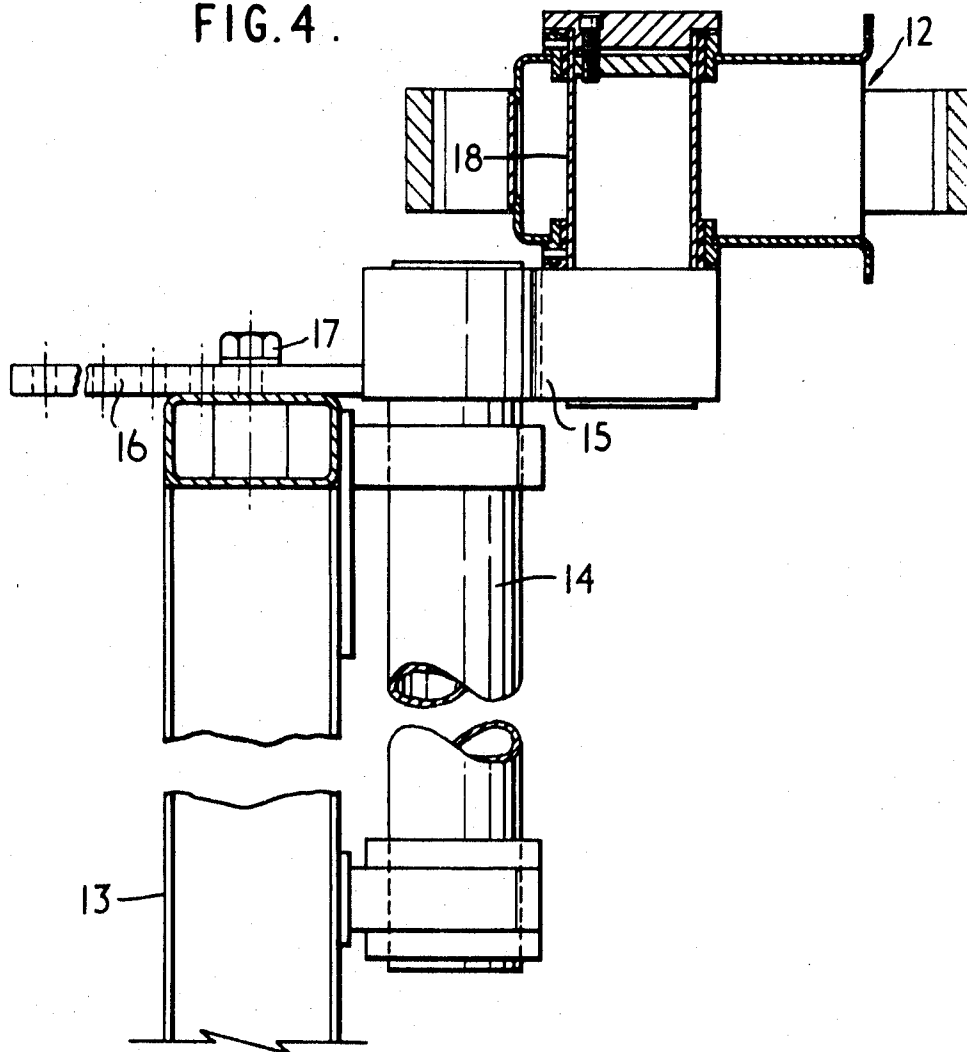


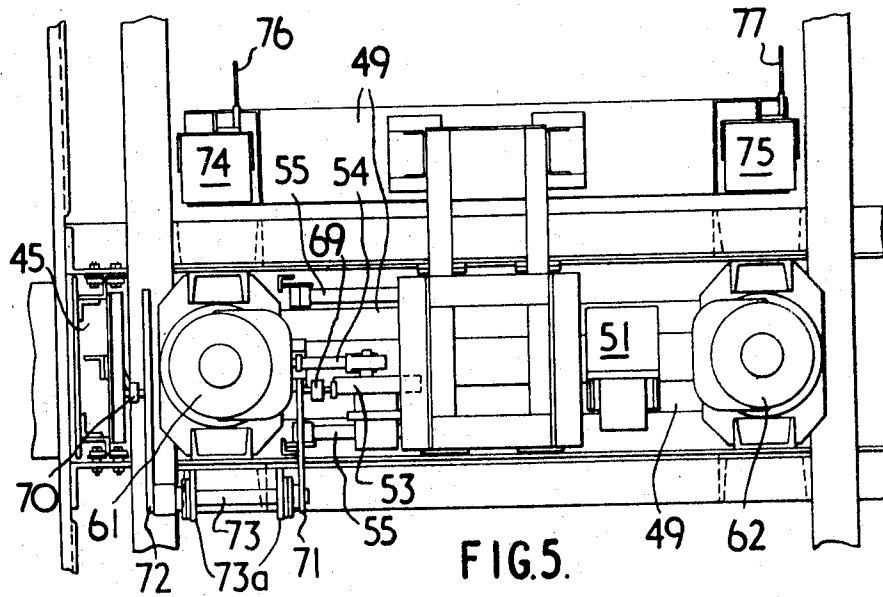
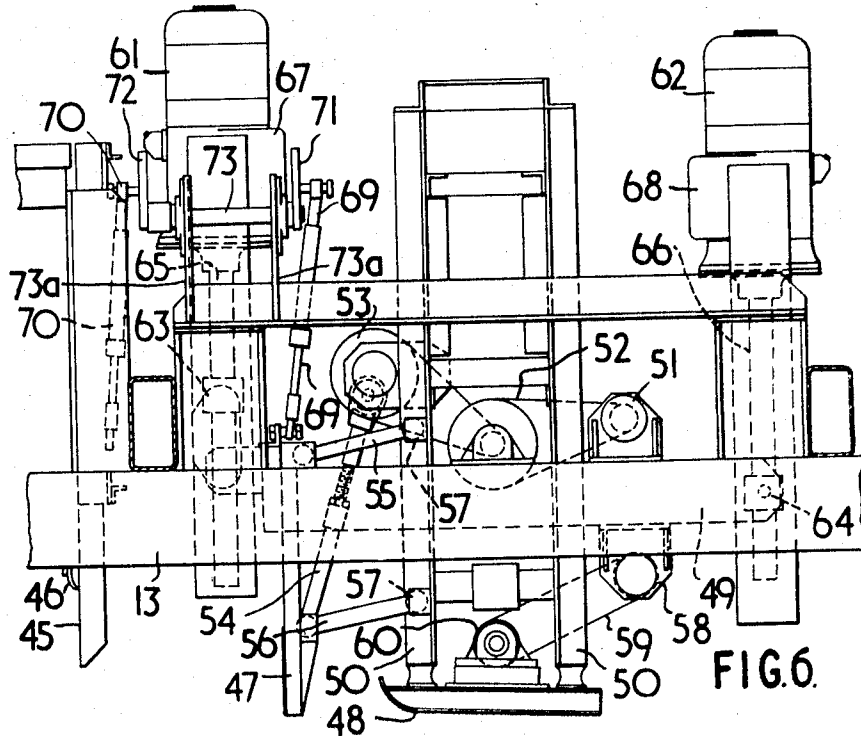
FIG. 3.

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FIG. 4.



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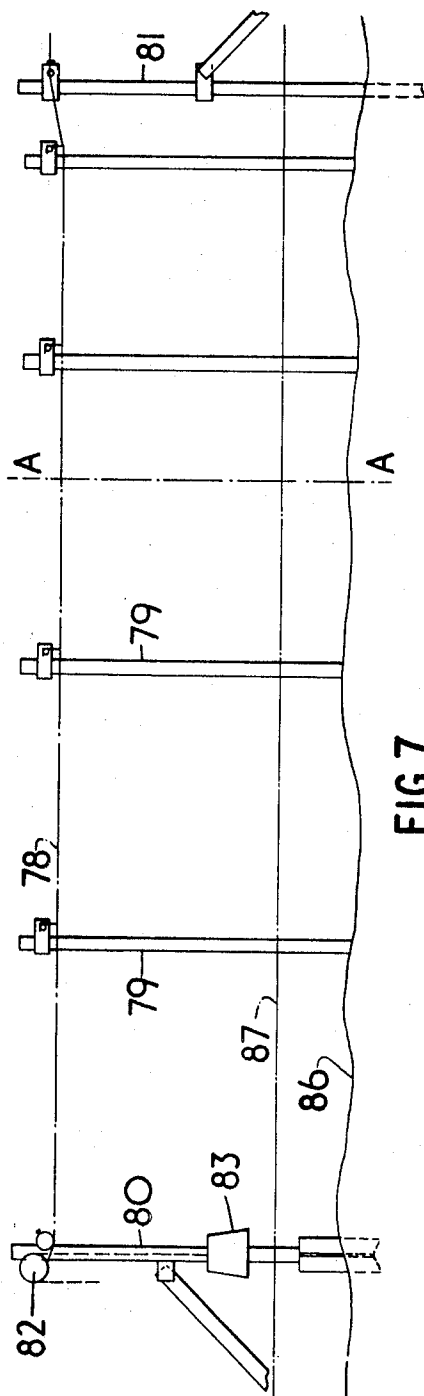


FIG. 7.

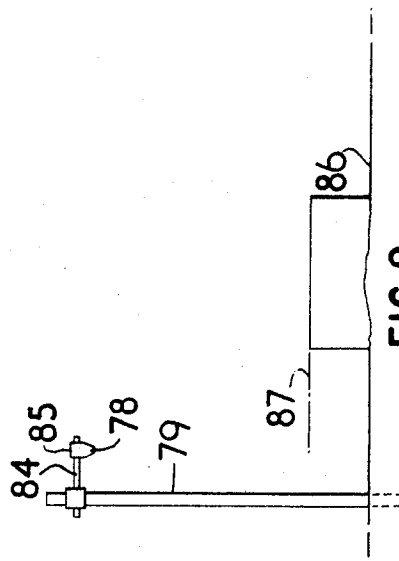


FIG. 8.

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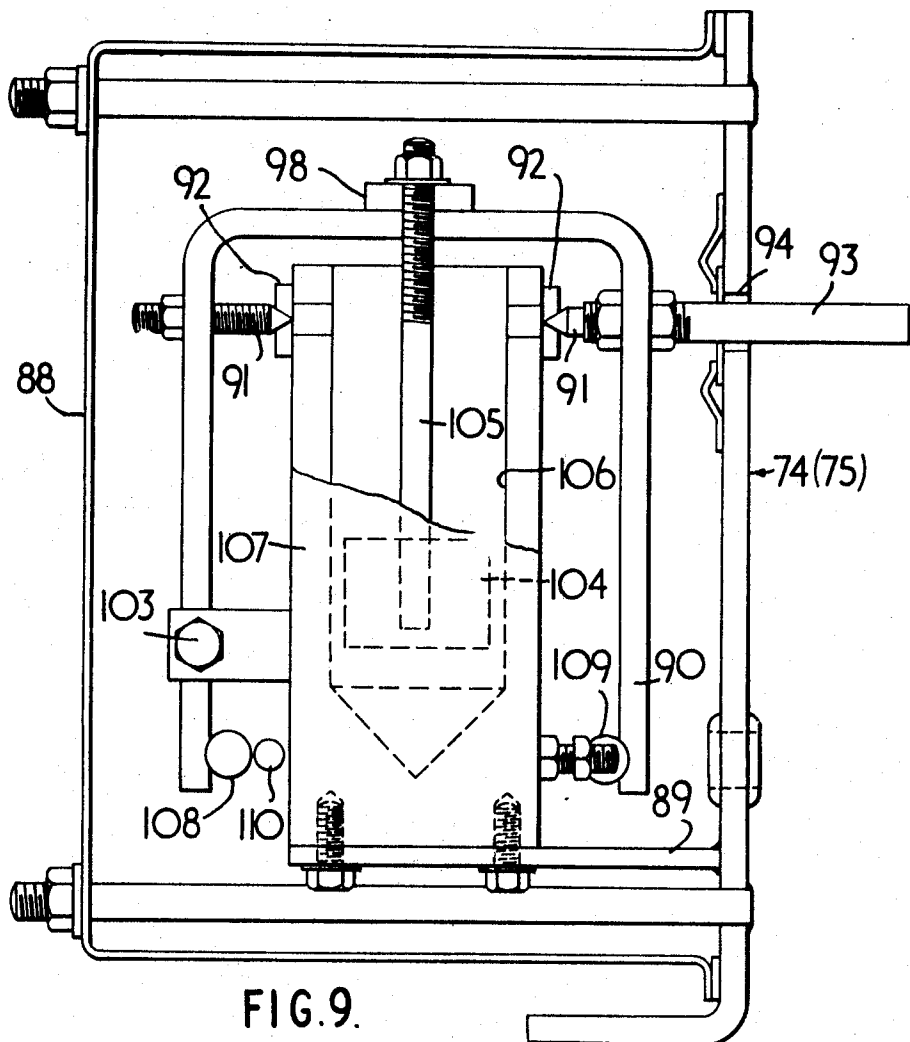


FIG. 9.

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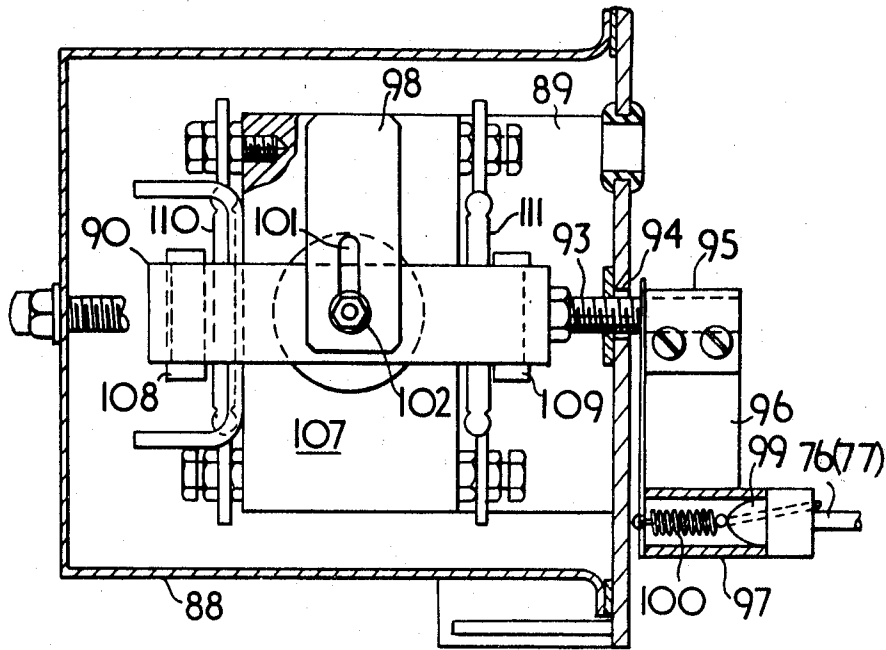


FIG. 10.

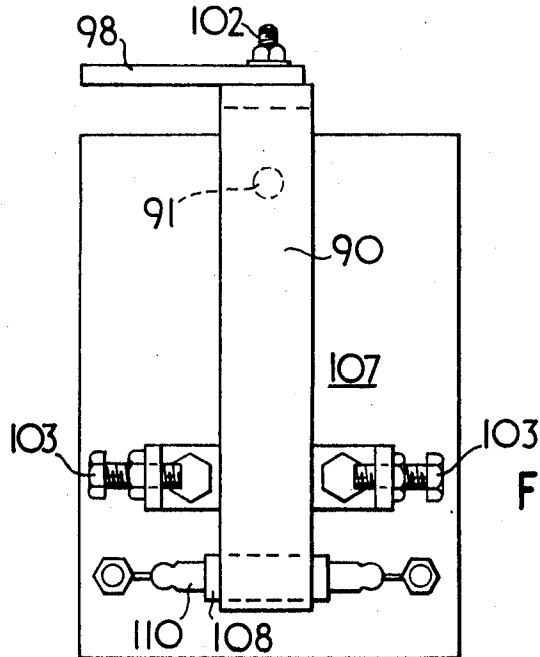


FIG. 11.

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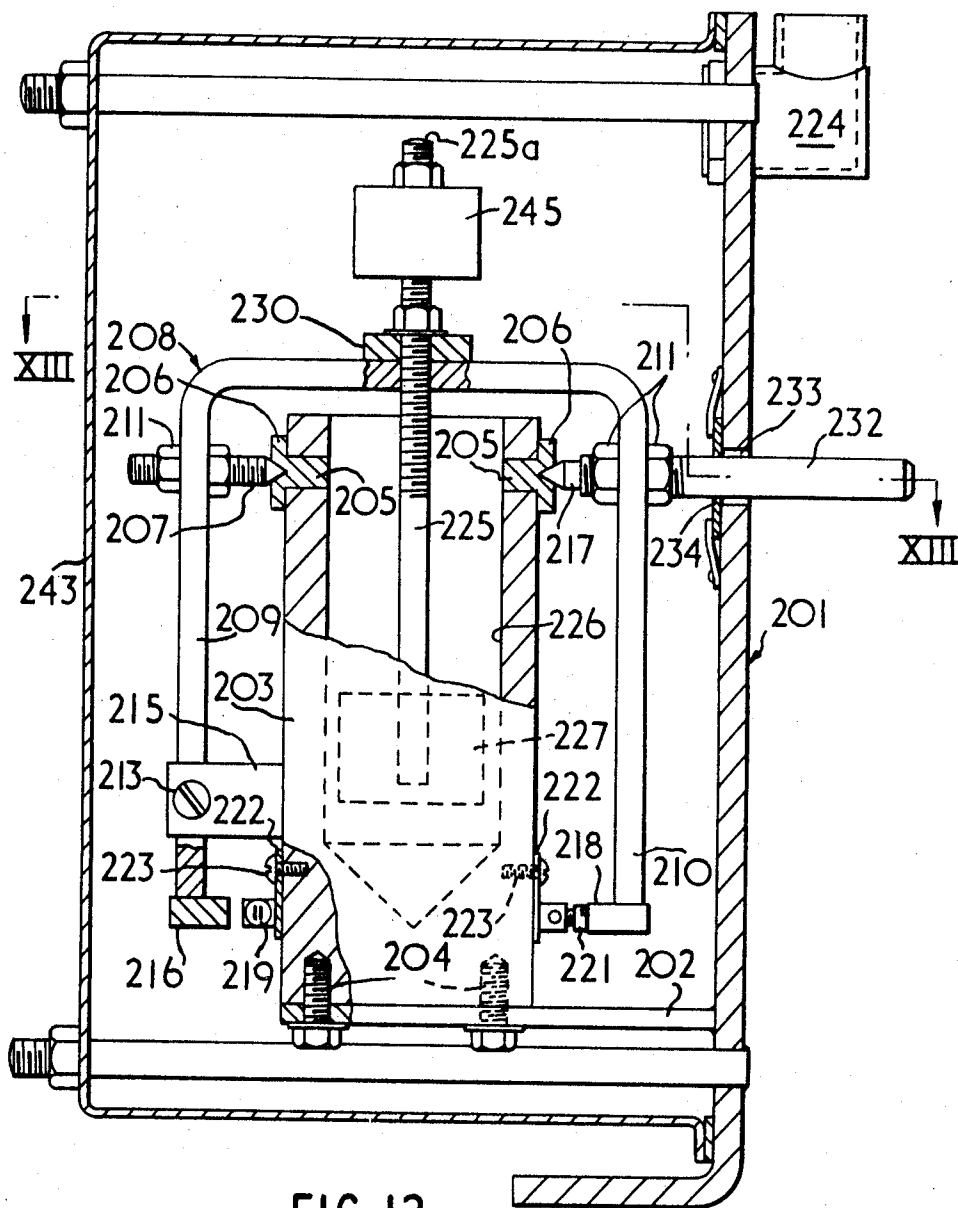
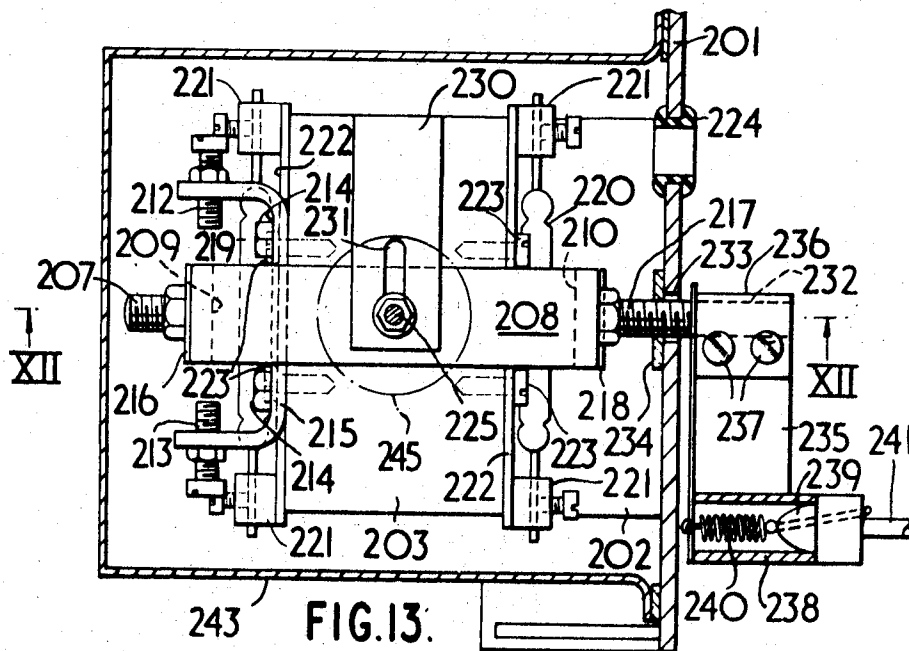
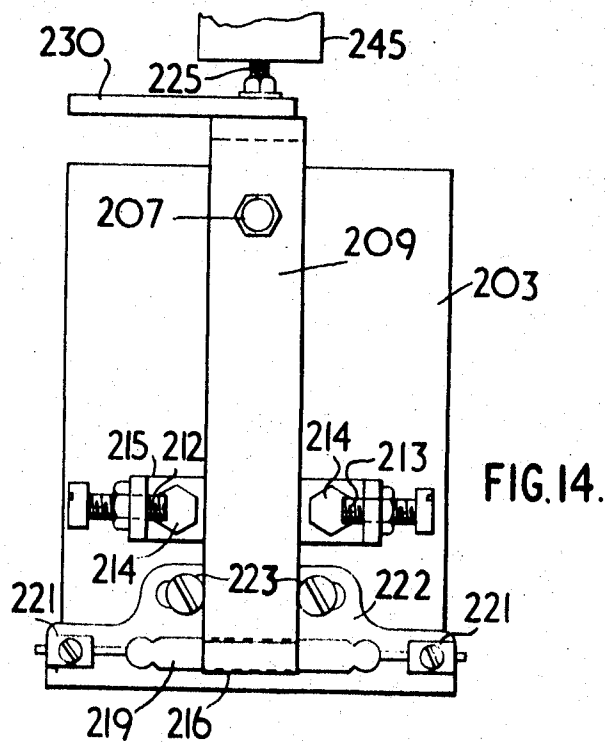


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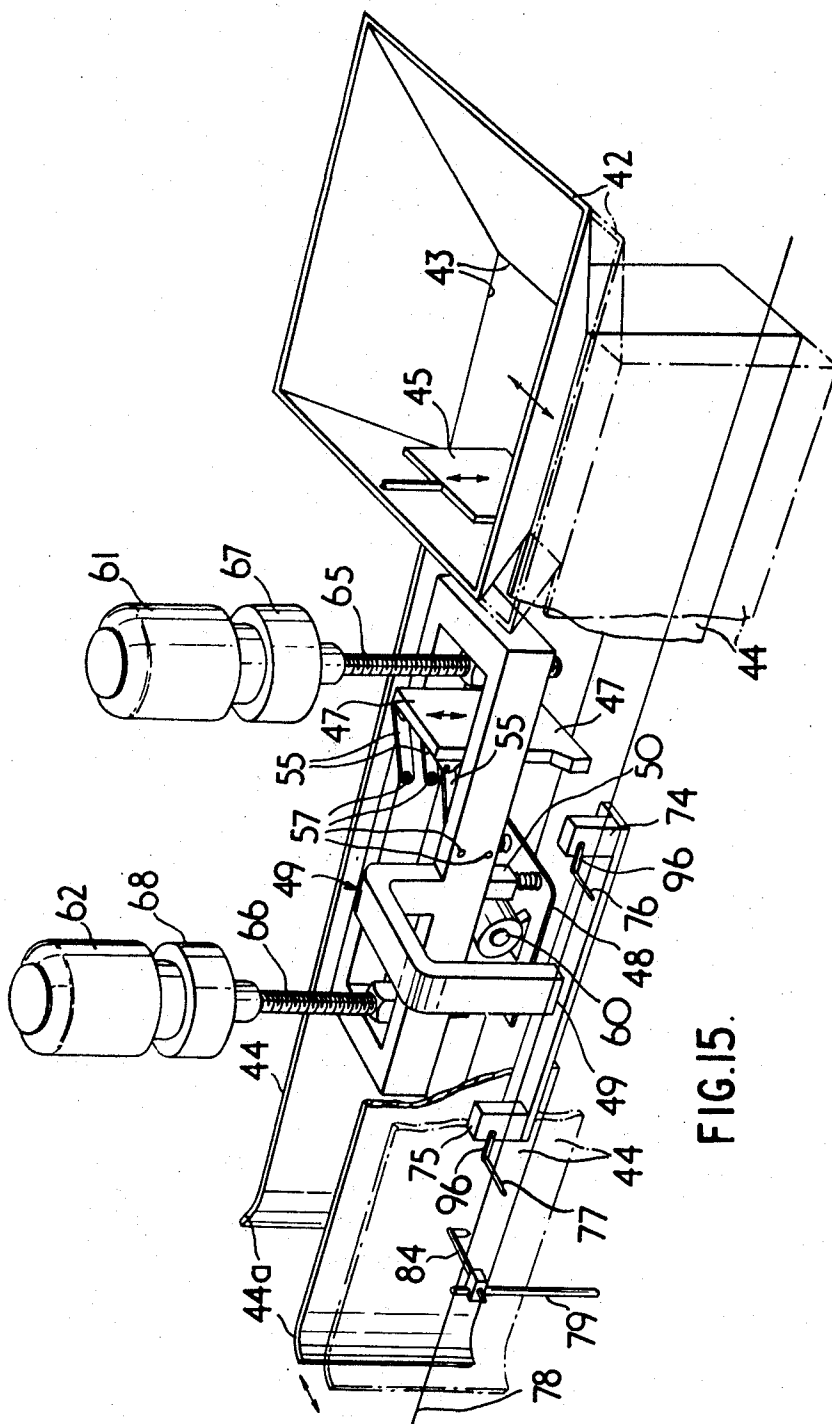
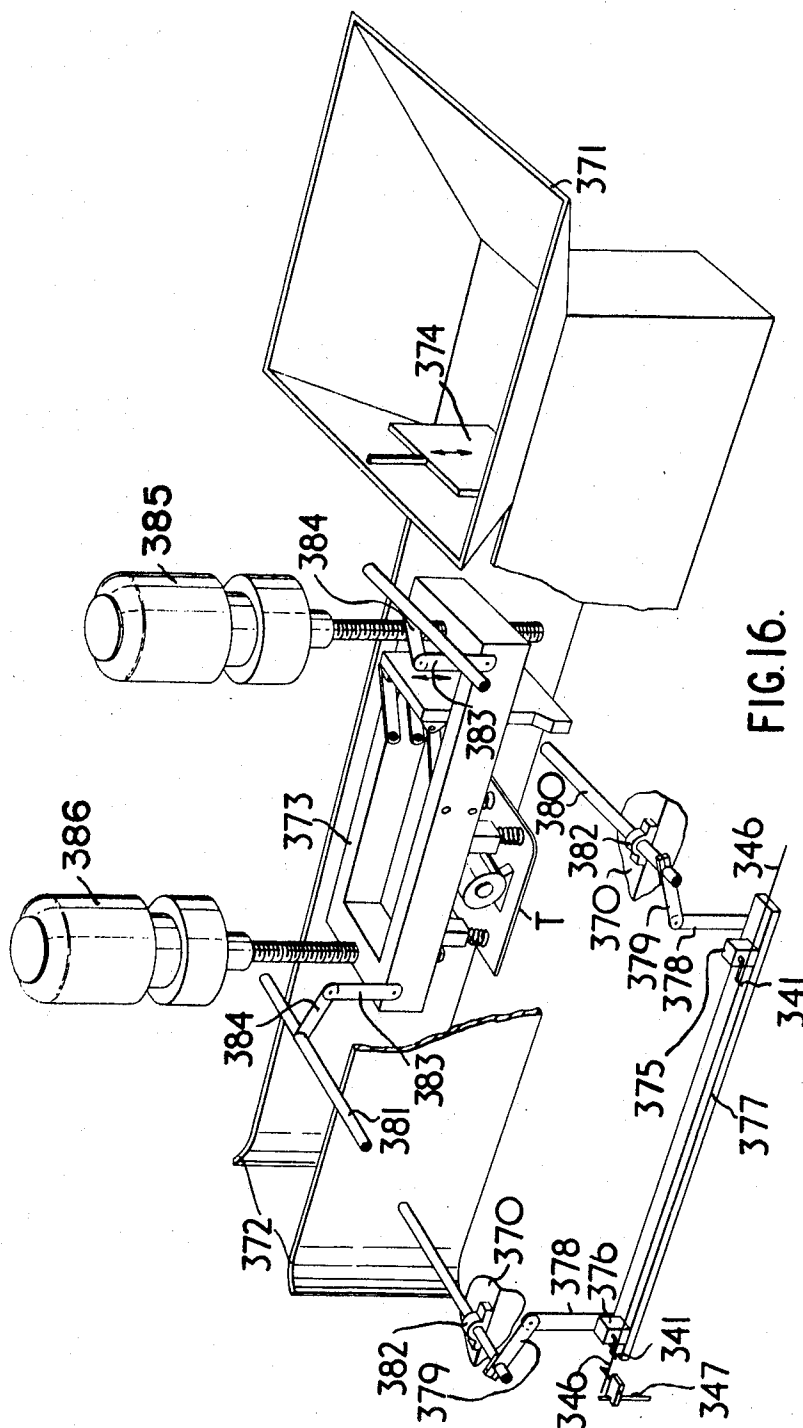


FIG. 15.

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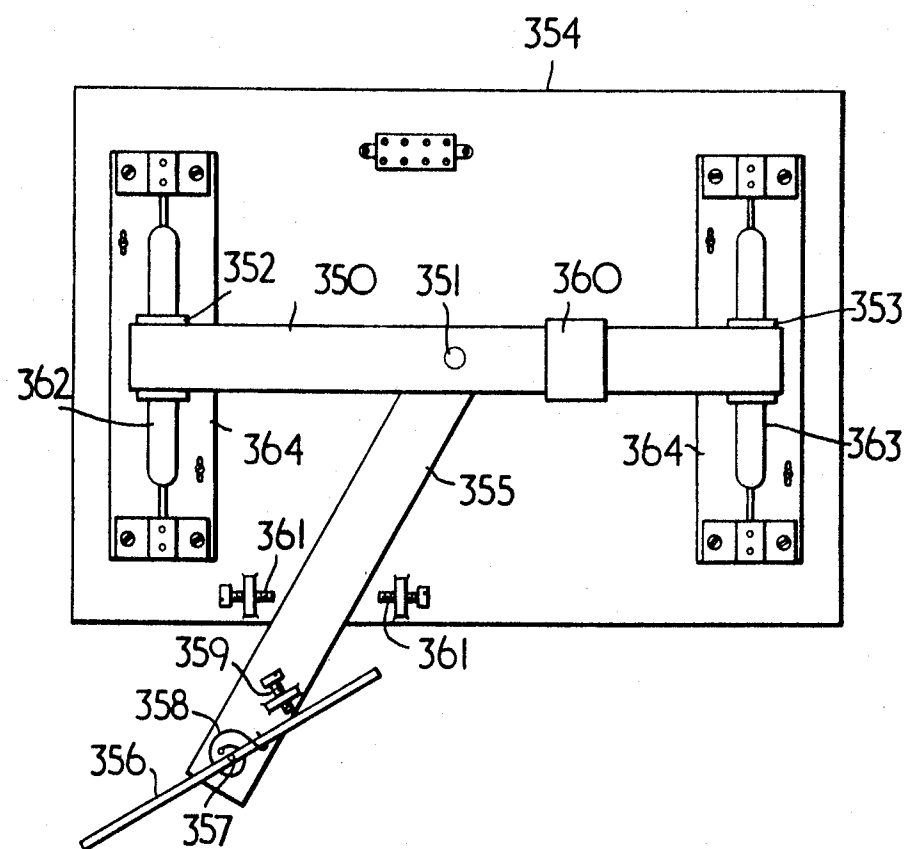


FIG. 17.

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LAYING OF CONCRETE CURBS, HAUNCHES AND THE LIKE

This invention relates to a method and apparatus for continuously laying a concrete curb, bankette, strip or haunch by a slip form process, in which the surface level of the laid concrete is controlled to follow a predetermined datum line. The invention is especially applicable to road construction.

In accordance with one method of road construction, after the necessary excavations have been carried out to provide an earth surface on which the road foundations can be laid, a gradeline is set up at each side of the roadway to provide a datum level from which the direction and height of the road surface can be determined. This gradeline conveniently takes the form of a taut wire or cable, or the like, held by supports at, say, 25-foot intervals so that the sag of the taut wire is kept to a practicable minimum. A haunch, whose upper surface is kept parallel to the taut wire, is laid at each side of the roadway, and this haunch forms the accurately positioned base upon which the formwork is to be mounted. Since the concrete haunch is eventually buried in the material of the finished roadway, it is normally of a lean, dry mix, that is to say, having a cement-aggregate ratio of 1:15 to 1:20.

The method and apparatus according to the present invention are primarily intended for the laying of such haunches, but it is to be understood that the invention is also applicable to various types of slip form paving using quality concrete of low slump.

In the method of laying a concrete curb, strip, bankette or haunch according to the invention, the concrete is deposited between slip forms at a depth determined by an adjustable gate, and the deposited concrete is compacted to a level derived from a present datum and established by a tamper and a smoothing tool. The operative heights of the tamper and the smoothing tool are continuously controlled by sensing means which follow a taut datum wire or cable representing the present datum, and the gate is adjusted in accordance with signals from the sensing means so that the degree of compaction of the laid concrete is kept constant irrespective of ground irregularities. Thus, if the operative heights of the tamper and smoothing tool are raised through a certain distance, relative to the machine, to maintain the required top surface level of the haunch where there is a depression in the ground, it is necessary to raise the gate by more than this distance in order to deposit a volume of concrete which will have the required depth after compaction.

According to one aspect of the invention a machine for laying a concrete curb, strip, bankette or haunch in accordance with a predetermined datum line provided by a taut wire or the like, comprises a mobile carriage having a hopper from which the concrete is discharged between slip forms and levelled, wherein the depth of the laid concrete is continuously controlled by tools carried on a subframe whose vertical height is continuously adjusted by means responsive to sensing members which mechanically engage the wire. The sensing members may consist of pivoted arms which are biased into engagement with the wire, from above or below, and operate switches which control electrical circuits for the levelling means. Preferably the pivoted arms carry permanent magnets which actuate reed switches magnetically.

According to another aspect of the invention, in a machine for laying a concrete curb, strip, bankette, or haunch in accordance with a predetermined datum line provided by a taut wire or the like, the machine being of the kind comprising a mobile carriage having a hopper from which concrete is deposited between slip forms and thereafter treated successively by a vertically adjustable gate for controlling the rate of deposition of concrete, and a tamper and smoothing plate for compacting the concrete to the desired level, the tamper and smoothing plate are carried by a frame whose ends can be raised or lowered automatically e.g., by reversible motors, which may be electric or hydraulic, separately controlled in accordance with signals from sensing devices which engage the wire or the like, the gate being coupled to the frame and

actuated thereby so that its height changes are proportional to the height changes of the frame.

A valuable modification of the invention involves mounting the sensing devices on a separate platform or like carrier suspended from the main frame or chassis of the machine and coupled to the subframe carrying the tamper and smoothing plate in such a way as to move in unison therewith.

Preferably, the coupling consists of a mechanical linkage having its main pivots on the machine chassis. This linkage may include a torsionally substantially rigid tube or rod journaled on the chassis and a link at each end thereof pinned, respectively to the platform and to the subframe.

Conveniently in such an arrangement a sensing device comprises a magnet carrier mounted on a generally horizontal pivot for angular deflection in a substantially vertical plane about a neutral or mean position, the carrier being free to deflect between limit positions in either or both of which a magnet on the carrier operates a magnetic switch for controlling the position of the subframe.

Another aspect of this invention relates to displacement detecting devices of a nature which can be used in the haunch-laying equipment described above, although not confined to such use. An object of this aspect of the invention is to provide a device in which switches are selectively operated in response to the displacement of a carrier control element in either direction from a null position. The device is primarily intended for the control of a component to maintain it in a predetermined or null position or attitude relative to a datum. Such component may, for example, be an assembly of levelling and compacting tools of the concrete haunch or curb-laying machine used in road construction, the datum being represented by some fixed device such as a taut wire.

It is another object of the present invention to provide displacement detecting devices in which the control of "forward" and "reverse" circuits is performed by magnetic fields acting on magnetically responsive switch elements, thereby eliminating direct mechanical contact between the movable carrier or control element and the switches themselves. This results in higher sensitivity to small deflecting forces acting on the control element.

According to this aspect of the present invention, the control element is constituted by a carrier mounted for pivotal deflection between two limit positions and having a pair of permanent magnets mounted thereon, each magnet being adapted to effect operation of respective switch contacts on opposite sides of an intermediate neutral or null position between the limit positions of deflection of the carrier.

Each pair of switch contacts may be normally closed and opened by the action of its magnet, but generally a magnet, upon displacement to a position for effective actuation of its switch contacts, causes closure thereof, the switch contacts being spring-biased to the normally open position. It will be understood that the switch contacts may operate relays, contactors or the like.

In one practical application of the invention, the carrier is controlled by a sensing element.

Advantageously, the carrier is of inverted U-shape and has the magnets mounted adjacent the free ends of the respective limbs of the U, and pivots are mounted on the limbs adjacent their roots, the pivots being coaxial in the plane of the axes of the two limbs of the U.

The invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIG. 1 is a side elevation, omitting some parts for clarity, of a concrete haunch-laying machine according to the invention;

FIG. 2 is a plan view of the machine;

FIG. 3 is an end elevation on the arrow III of FIG. 1 with some parts omitted for clarity;

FIG. 4 is an enlarged section on line A—A in FIG. 2 and looking in the direction of the arrows but turned counterclockwise 90°;

FIG. 5 is an enlarged plan view of the tamping and levelling control mechanism;

FIG. 6 is a side elevation of FIG. 5;

FIG. 7 is a diagrammatic side view of the datum wire and its supports;

FIG. 8 is a section on the line A—A in FIG. 7;

FIG. 9 is a side elevation of a level-control unit of the machine;

FIG. 10 is a part-sectional plan of FIG. 9;

FIG. 11 shows a detail of FIG. 9,

FIGS. 12 and 13 and 14 show a variant of a level-control unit, the view being respectively as those of FIGS. 9, 10 and 11

FIG. 15 is a simplified scrap perspective view of the adjustable tool-carrying subframe of the machine shown in FIGS. 1 to 6 and associated components, and showing also modified slip forms.

FIG. 16 shows a scrap perspective of a different embodiment of subframe, and

FIG. 17 shows a sensing device especially suitable for use with the embodiment of FIG. 16.

The machine comprises a mobile carriage 10 mounted on a pair of endless track units, 11, 12, to which it is connected by a three-point support. The main frame is connected to the track unit 11 at fore-and-aft positions (not shown) and to the track unit 12 at an intermediate position, a detail of the latter connection being shown in FIG. 4. The support is such that the relative height of the main frame to the track unit 12 can be present so that the two tracks can run at different ground levels. As shown in FIGS. 3 and 4, the main frame 13 carries a tubular shaft 14 at the end of which is a crank arm 15. The crank arm is set in the required position by a plate 16 which is locked in position by a bolt 17, and carries a bearing pin 18 by which it is ultimately connected to the track unit 12.

The driving wheels 19, 20 of the track units are driven by hydraulic motors 21, 22 through flexible couplings 23, 24 and worm reduction units 25, 26. The outputs from the worm-reduction units are taken through chain-drive reduction units 27, 28 to the driving wheels. The motors 21, 22 are fed with pressurized fluid from pumps 29, 30 which are driven from an internal combustion engine 31 through belt and pulley drives 32, 33, the common drive shaft 34 of which is mounted in bearings 35, 36 and coupled by a coupling 37 to the crankshaft of the engine. The engine also drives an electric generator 39 through a belt and pulley drive 40, and further hydraulic pumps referred to later.

At the front end of the machine is a hopper 42 having a discharge opening 43 (FIG. 2) through which the concrete is deposited between slip forms 44 (see also FIG. 15). As indicated in FIG. 15, the "inboard" slip form is preferably adjustable laterally in the machine to accommodate various widths of concrete haunch, and the corresponding sidewall of the hopper 42 is then also adjustable to vary the widths of the discharge opening 43. The level of the deposited concrete is continuously controlled by means of a vertically adjustable gate 45, against which bears a wiper blade 46 (FIG. 6) mounted on the backplate of the hopper 42 to prevent concrete from entering the gate guide opening. Behind the gate 45 are tamper and smoothing tools 47, 48, respectively which are supported from a common subframe 49, the smoothing plate 48 being connected to its supports 50 by rubber blocks for absorbing vibrations. A hydraulic motor 51 (FIGS. 5 and 6) is mounted on the subframe 49 and connected through belt-reduction gearing 52 to a crank 53 which reciprocates the tamper 47 by a connecting rod 54.

The tamper tool 47 is constrained to follow an approximately vertical path by a pair of parallel links 55, 56 connecting it with the vertical supports 50. The connections to the ends of these links are by way of rubber bushes 57. A second hydraulic motor 58 mounted on the subframe 49 is connected by a belt drive 59 to an eccentric mass type of vibrator 60 for vertically vibrating the smoothing plate 48. The motors 51 and 58 are fed from a pump 38 (FIG. 2) which in turn is driven from the engine 31. Height adjustment of the gate 45, tamper 47 and smoothing plate 48 is by means of a pair of reversible electric motors 61, 62 energized by the generator 39.

The two ends of the subframe 49 are connected by a pivoted link 63 and a pivot 64, respectively (see FIG. 6), with lead

screws 65, 66 (see FIG. 15) for height adjustment, the two lead screws being coupled to the motors through spur-reduction gearboxes 67, 68. The forward end of the subframe 49 and the gate 45 are connected through respective swivel-ended adjustable links 69, 70 to a pair of crank arms 71, 72 keyed to a common shaft 73. The shaft 73 is journaled in a bracket 73a fixed to the main frame of the machine. In this way, any vertical adjustment of the front end of the subframe, relative to the main frame, is always accompanied by a corresponding, proportional adjustment of the gate 45. The ratio of the lengths of the crank arms 71, 72 is such that the movement of the gate is greater than that of the subframe so as to maintain a constant compaction ratio of the concrete.

Each motor 61, 62 is controlled by its own control unit 74, 75 (FIGS. 2, 5 and 15) mounted on the subframe, which is actuated by a respective sensing or detector element 76, 77 engaging a taut datum wire 78. This datum wire is positioned as near the center line of the slip forms as is practicable in order to minimize positional errors of the tamper and smoothing tools 47, 48 due to canting or tilting of the machine. The wire 78 is thus straddled by the machine during the haunch-laying operation as shown in FIGS. 1-3 and 15.

Basically, each sensing element comprises an arm pivoted about a horizontal axis and biased into engagement with the underside of the wire. Two permanent magnets are mounted at the inner end of the arm, and these magnets operate reed switches to energize the motor in one or other direction according to whether the arm lies above or below a center position in which the reed switch is open and the motor not energized.

FIGS. 7 and 8 illustrate the datum wire. The wire 78 is suspended from stakes 79 spaced at 25-foot intervals and stretched to the required tension between end posts 80, 81, the wire passing round a pulley 82 on the post 80 and the pulley incorporating a one-way sprocket which is weighted by a weight 83. Each stake 79 carries a horizontal arm 84, whose vertical position is accurately set in accordance with the required datum level, and a plate 85 is set at the required horizontal position on this arm. The wire 78 passes through a notch in the bottom of the plate 85 and is retained therein by a light tension spring suspended from the arm 84. In FIG. 7 the ground level is indicated at 86, and the required level of the haunch is indicated at 87.

Referring now to FIGS. 9-11, each control unit 74 or 75 comprises a mild steel casing 88 having an insulating block 107 rigidly mounted on a plate 89. A channel-shaped aluminum carrier 90 is pivotally mounted on this block by needle bearings 91 whose pointed ends engage with bearing surfaces provided by hardened steel inserts 92 in the block. Secured to the carrier 90 in alignment with the axis of the pivot is a spindle 93 projecting through an opening 94 in the casing. As shown in FIG. 10, the spindle 93 carries a collar 95 which supports a plate 96, and a hollow cylinder 97 is secured to the other end of the plate. The arm of the sensing element 76 (or 77), which is biased against the underside of the wire 78 by means of an adjustable weight 98 mounted on the top of the carrier 90, extends from an acorn fitting 99 which is located in the open end of the cylinder 97 and retained therein by a tension spring 100. To permit adjustment of the weight 98, it is slotted at 101 and clamped in position by a clamping nut 102.

It will be seen that, as the machine follows undulations in the ground while the sensing element 76 (or 77) remains in contact with the datum wire, the spindle 93 will be deflected by relative movements between the sensing element and control unit casing, and the carrier 90 will be tilted correspondingly. The extent of tilting is limited by adjustable stops 103. In order to reduce vibration of the carrier, the latter carries a damper blade 104 mounted at the end of a spindle 105 and dipping into a bath 106 of silicone liquid within the block 107. Each limb of the carrier 90 carries a permanent magnet 108, 109 which cooperates with and actuates a respective reed switch 110, 111 magnetically, the motor 61 (or 62) being energized for rotation in one or other direction accord-

ing to which of the reed switches is closed. Several combinations of reed switches and magnets are possible, but it is preferred to use a system in which the motor is deenergized (i.e., both switches open) for the shortest practicable travel of the carrier 90 through its center position, since this provides the most sensitive control.

The machine is steered by controlling the drive to the track units differentially. A bridge 112 (FIG. 2) carries levers 113, 114 which control the outputs of the pumps 29, 30 through connecting rods and valves (not shown). In practice these control levers provide a coarse adjustment for both pump units, and one is normally present to a required setting; a fine control lever 115 operates a cam unit 116 which optionally interlocks the levers 113, 114 and thereby moves the levers differentially to provide a fine adjustment for one of the pump units. The lever 115 is continuously manipulated to provide the necessary differential adjustments for the other pump unit. If the machine is steered manually, the operator sights the datum wire by means of mirrors so as to keep the wire between specified markings on a scale.

In a modification steering is carried out automatically the machine being controlled to follow a predetermined course set by the datum wire. In such a case the coarse control lever is preset as for manual steering and a servomechanism (not shown) provides fine adjustment of one pump. The servomechanism is actuated in accordance with the position of a pivotal probe biased laterally against the wire and preferably constructed in similar manner to the elements 76, 77 for level control.

When the machine is being used to lay a narrow strip of concrete, such as a haunch of 12 inch width, it is not normally necessary to compensate for crossfall, but in the laying of substantially wider strips it is usually necessary to provide additional control means for keeping the surface of the strip level. This is accomplished by continuously supervising and adjusting the height of the drive track unit 12 relative to the machine frame. To this end, the crank arm 15, instead of being clamped by the plate 16 (FIG. 4), is free to swing about the axis of the shaft 14, and its position is controlled by means of a reversible electric motor (not shown) operated by a pendulum or similar type of switch. Any movement of the switch from its center position, corresponding to the machine being horizontal, closes a control circuit of the motor, which drives the crank arm and thereby returns the track unit to its datum level. The pendulum switch may be similar in design to the switch unit 88 of FIGS. 9-11, a separate pendulum preferably being coupled to the spindle 93.

FIG. 15 as well as being a scrap view of the general arrangement illustrates a modified machine which is specially adapted to negotiate curves of small radius, which may be as small as 50 feet. As shown in the drawing, the slip forms 44 are shortened considerably and have flare plates 44a fitted at their rear ends. In other respects the machine is substantially the same as the one hereinbefore described.

Any of the machines described may be provided with a feeding device (not shown) in the form of a small high-speed electric conveyor with a receiving hopper at its outboard end. The feeding device would be suspended from an A-frame over the main hopper 42 of the machine and extend forwards so that the receiving hopper is ahead of the machine. The inboard end of the feeding device would be pivoted horizontally and vertically so as to allow the receiving hopper to be positioned on either side of the datum wire as required.

Although the variant shown in FIGS. 12, 13 and 14 will be generally understood from the description of the broadly similar FIGS. 9, 10 and 11 it will for the sake of completeness now be described in more detail.

The displacement-detecting device shown in FIGS. 12-14 includes an upright supporting frame or bracket 201 from which projects a nonmagnetic plate 202 serving as a mount for a block 203 of insulating material secured in position by screws 204.

Near its upper end the block 203 carries, on opposite sides, hardened steel inserts 205 having heads or flanges 206 formed with cup-shaped or conical indentations to form seatings for coaxial needle-bearing pivots 207, 217 pivotally supporting an inverted U-shaped yoke or carrier 208 of aluminum or other nonmagnetic material. As shown, the pivots 207, 217 are axially adjustable, being screwed through threaded holes in the upper opposite limbs 209, 210 of the carrier and secured in their adjusted positions by locknuts 211.

The carrier 208 has a neutral position, normally a position in which the limbs 209 and 210 hang vertically midway between two limit positions determined by engagement of the arm 209 with stop screws 212, 213 mounted in a U-shaped support 215 bolted at 214 to a side of the block 203, the screws 212 and 213 being locked in their adjusted positions by locknuts. Mounted on the carrier are two permanent magnets 216 and 218 mounted on the limbs 209, 210 respectively near their lower ends.

Each of the magnets is associated with a respective magnetically actuated reed switch. Thus the magnet 216 is associated with and is adapted to effect operation of the contacts of a switch 219 and the magnet 218 is associated with and is adapted to effect operation of the contacts of a switch 220. Each of the switches 219 and 220 as illustrated in the drawings consists of at least a pair of contacts, one of which is movable by an armature, sealed into a glass or other nonmagnetic gas-impervious envelope. Each is supported by its end connections in a pair of sockets 221 on an adjustable carrier plate 222 adjustably clamped on the block 203 by means of screws 223. The sockets 221 supporting a switch also serve as terminals for that switch, and the bracket 201 is formed with an aperture fitted with a grommet 224 of insulating material for the passage of leads to the switch terminals.

Midway between the limbs 209 and 210 the yoke carries a depending central rod 225 projecting into chamber 226 formed in the block 203 and containing a suitable liquid such as a silicone. At its lower end the rod carries a damper vane 227 submerged in the liquid. The rod 225 passes through a threaded hole in the carrier 208 and serves as a bolt for clamping on the carrier 208 a biasing arm 230. The arm is slotted at 231 for adjustment of the bias-loading and projects at right angles to the pivot axis of the carrier 208 so as to bias the carrier by gravity towards one of its limit positions. The rod 225 is extended upwards at 225a to provide an adjustable mounting for a dynamic balance weight 245 so that the assembly of carrier 208 and weight 245 becomes a compound pendulum.

An operating spindle 232 integral with or secured to the needle bearing 217 projects through a sealing washer 234 in an aperture 233 in the bracket 201. Clamped to the spindle 232 is a crank arm 235 which includes a split collar 236 clamped onto the spindle by screws 237. The crank arm carries at its outer end a hollow cylinder 238 in which seats an acorn fitting 239 retained therein by a tension spring 240. A sensing rod 241 projects from and is fixed in the acorn fitting. The whole switching unit is enclosed in a sealed casing 243.

In use, the sensing rod 241 is biased by the biasing arm 230 against a control element such as a taut datum wire in the direction of length of which a vehicle carrying the switching device moves. In such a case, deviation of the bracket 201 from a desired contour defined by the datum wire will be accompanied by angular deflection of the crank arm 235 under the influence of the sensing rod 241 and corresponding rocking of the carrier 208. As the latter moves from its neutral position through a predetermined small angle towards the one or the other of its two limit positions, one or the other of the switches 219 and 220 is actuated by proximity of, and under the influence of, the associated permanent magnet 216 or 218.

Should the sensing rod 241 encounter an obstruction, the rod deflects through rotation of the acorn fitting 239 relative to the cylinder 238 against the biasing force of the spring 240 and so minimizes the danger of damage to the arm 241 or another part of the switching device. Moreover, the acorn fitting limits the force exerted on the crank arm 241 by the

datum device after the arm 209 has engaged a stop 212 or 213.

Several combinations of reed switches and magnets are possible, but it is preferred to use a system in which a motor is deenergized (i.e., both switches 219, 220 open) for the shortest practicable travel of the carrier 208 through its neutral or central position, since this provides the most sensitive control.

Although in the drawings the magnets 216, 218 and switches 219, 220 are shown with their axes parallel in the horizontal plane, it is possible to obtain variations in the response characteristics of the device by modifying these spatial relationships. For example, the axes of the magnets can be rotated through 90° in the horizontal plane, or the axes of the switches can be rotated through 90° in the vertical plane.

By a small modification, the sensing device may be arranged to control a servomechanism or the like in order to govern movement of a vehicle in a horizontal plane. To that end the sensing rod 241 is so positioned that, with the carrier 208 in its neutral position, the rod extends vertically from the spindle 232. The switching device may be mounted at the front of a vehicle and in operation the biasing member 230 acts to bias the sensing rod against a side of a datum device defining the desired course of the vehicle. Deviation from that course is accompanied by rocking of the carrier 208 towards one or other of its limit positions and corresponding energization of a servomechanism or the like in the forward or reverse direction corrects the course followed by the vehicle.

The sensing device may be adapted to regulate the angular position about an axis of a body which is free to rock about that axis. To this end the biasing member 230 is removed, a pendulum is coupled to the spindle 232 and the switching device is mounted to rock with the said body so that, when the body is in the desired angular position, the pendulum hangs vertically and the carrier 208 is in its neutral position, while rocking of the body from the desired angular position is accompanied by corresponding rocking of the carrier under the influence of the pendulum relatively to the bracket 201 and parts secured thereto. Consequently one of the limits 219 and 220 is operated to effect energization of a servomechanism or the like to operate in a corresponding direction to correct the angular position of the body.

Referring now to FIG. 16 of the drawings, a curb or haunch-laying machine of the kind described with reference to FIGS. 1 to 6 and 15 consists of a frame or chassis (indicated fragmentarily at 370) supported on wheels or tracks (not shown) and carrying a hopper 371 for concrete, slip forms 372 which support the concrete discharged from the hopper, and a subframe 373 carrying smoothing and tamping tools T. These in conjunction with an adjustable gate 374 controlling the outlet from the hopper 371, govern the level of the top surface of the haunch in accordance with signals from a pair of sensing devices 375, 376, each having its sensing tip 341 in engagement with a taut wire or similar datum 346 for the haunch. This wire is carried on leveling posts 347.

The devices 375, 376 are carried on respective ends of a rigid platform 377 suspended from the chassis 370 by links 378 and crank arms 379 clamped on respective front and rear torque tubes 380, 381. The latter are mounted in bearings 382 on the chassis 370. Similar links 383 and arms 384 couple each torque tube 380, 381 to the respective end of the subframe 373. Thus, vertical displacements of the subframe relative to the chassis 370 are repeated exactly by the platform 377 so that the necessary followup action is applied to the sensors 375, 376 as they detect deviations of the subframe 373 from the level set by the datum wire 346. The correction signals from the sensors 375, 376 are fed to corresponding level control motors 385, 386 which adjust the height of the respective ends of the subframe 373.

As will be understood, there are many other alternative practical applications of the present invention.

The sensors 375, 376 may be constructed in the manner described with reference to and illustrated in FIGS. 9 to 11, or 12 to 14 for example but FIG. 17 of the accompanying

drawings illustrates a modification particularly suitable for the arrangement of FIG. 16 in which a straight bar carrier 350 is pivoted centrally at 351 and has a magnet 352, 353 mounted transversely at each end. The pivot 351 is secured on a rigid backplate 354 adapted to be mounted in a vertical plane. A feeler arm 355 is fixed at an angle to the carrier bar 350 and has a balanced sensing flap 356 pivoted thereto at its free end. The pivot 357 of the sensing flap is located at its center of length, and the flap is biased by a spiral spring 358 against an adjustable stop 359, the spring 358 normally holding the sensing flap 356 in contact with the stop 359. The carrier bar and feeler arm assembly is balanced about the pivot 351 by a balance weight 360. A pair of adjustable stops 361 are mounted on the backplate 354 to limit the angular deflection of the carrier bar 350.

Adjacent each magnet 352, 353 are mounted respective magnetically operated reed switches 362, 363. These switches are mounted on baseplates 364 which are vertically adjustable for control of the instants of opening or closing in terms of angular deflection of the carrier bar 350.

In operation, the subframe 373 is first set to the required finished height of the curb to be laid. The height of the datum wire 346 relative thereto is accurately known, and the platform 377 is set to a height such that the carrier 350 is in its mean or neutral position when the tip of the sensing flap 356 rests under normal static load conditions on the datum wire.

As the machine 370 moves forward, following the datum wire 346, the flap 356 is held in contact with the wire by the resultant moment of the carrier and feeler arm assembly determined by the adjustment of the balance weight 360, and variations in the height of the chassis 370 relative to the datum will cause the flap to raise or lower the feeler arm 355 about the pivot 351. This deflects the magnet carrier 350 away from its neutral (horizontal) position, thus causing the reed switches 362, 363 to be selectively operated to energize their respective motor 385, 386 in the required sense to raise or lower the subframe 373.

The subframe raises or lowers the platform 377 in synchronism until the magnet carrier 350 resumes its neutral position. Thus the height of the curb being laid is maintained within close tolerance of that represented by the datum wire 346.

Although in the drawings the magnets 352, 353 and switches 362, 363 are shown with their axes parallel in the vertical plane, it is possible to obtain variations in the response characteristics of the device by modifying these spatial relationships. For example, the axes of the magnets can be rotated through 90° in the vertical plane, or the axes of the switches can be rotated through 90° in the vertical plane.

By a small modification, the sensing device may be arranged to control a servomechanism or the like in order to govern movement of a vehicle in a horizontal plane. To that end the pivot 357 is mounted vertically and the sensing flap 356 is positioned beneath the feeler arm 355 so as to pivot in response to lateral forces. The sensing device may be mounted at the front of a vehicle and in operation the flap 356 rests against the side of a datum device defining the desired course of the vehicle. Deviation from that course is accompanied by rocking of the carrier 350 towards one or other of its limit positions and corresponding energization of a servomechanism or the like in the forward or reverse direction corrects the course followed by the vehicle.

The switching device may be adapted to regulate the angular position about an axis of a body which is free to rock about that axis. To this end the balance weight 360, feeler arm 355, and parts attached thereto are removed, a pendulum is rigidly coupled to the carrier 350 and the adjustable stops 361 are repositioned to limit the excursions of the pendulum. The sensing device is mounted to rock with the said body so that, when the body is in the desired angular position, the pendulum hangs vertically and the carrier 350 is in its neutral position, while rocking of the body from the desired angular position is accompanied by corresponding rocking of the carrier under

the influence of the pendulum relatively to the backplate 354. Consequently, one of the switches 362 and 363 is operated to effect energization of a servomechanism or the like to operate in a corresponding direction to correct the angular position of the body.

The carrier bar 350 is shown in FIG. 17 in a horizontal means or neutral position, but any angle to the horizontal can be chosen as the neutral, including the vertical position.

Several combinations of reed switches and magnets are possible, but it is preferred to use a system in which a motor is deenergized (i.e., both switches 362, 362 open) for the shortest practicable travel of the carrier 350 through its neutral or central position, since this provides the most sensitive control.

We claim:

1. A machine for laying a longitudinally extended body of concrete to a surface level defined by a datum wire, irrespective of underlying ground irregularities, comprising:

a carriage mobile in the direction of the wire;

endless track units each supporting said carriage at a side thereof;

a hopper mounted directly on said mobile carriage;

slip forms beneath said hopper into which concrete may be filled from said hopper said slip forms being fixed in relation to said hopper and extending rearwardly of said hopper;

a vertically adjustable gate, a tamper and a smoothing plate extending in the given sequence within the slip forms from the hopper end of the slip forms;

a subframe generally located between said slip forms and adjustably mounted on said carriage, and itself mounting said tamper and smoothing plate and coupled to said gate; sensing devices which engage said wire;

and height-adjusting means for each end of the subframe each operable from a said sensing device to restoring any deviation of the subframe from a predetermined height in relation to the datum wire;

said gate being coupled to said subframe in such a way that its changes in vertical adjustment are proportional to the changes in height of the subframe in relation to the underlying ground.

2. A machine as claimed in claim 1, wherein the sensing devices include pivoted arms to engage said wire and wherein each height-adjusting means is operated by a motor including a control circuit operated by the movement of said pivoted arms.

3. A machine as claimed in claim 1, wherein each adjustable mounting for said subframe includes a pivotally mounted connecting means towards an end of the subframe, and a threaded portion within said connecting means, a generally vertically extending lead screw within said threaded portion: and wherein reduction gearing and a reversible electric motor operable in dependence on said sensing means and fixed in relation to the carriage are mounted on the upper end of each lead screw.

4. A machine as claimed in claim 1 wherein a forward end of said subframe is connected to said gate, the connection comprising:

a shaft;

first and second crank arms fixed to said shaft,

first and second connecting rods pivotally connected to said crank arms respectively, the first rod being also pivotally connected to the gate and the second rod being also pivotally connected to said forward end of said subframe; whereby any vertical adjustment of said forward end of

the subframe relative to said carriage is accompanied by a proportional adjustment of the height of the gate.

5. A machine as claimed in claim 4, wherein the ratio of the lengths of the crank arms is such that the movement of the gate is greater than that of the subframe so as to maintain constant the compaction ratio of the concrete.

6. A machine as claimed in claim 1, wherein the mobile carriage is mounted on the endless track units at three points.

7. A machine as claimed in claim 1, comprising a differential control means for the mobile tract units, in order to steer the machine, and further comprising:

a. a lateral-sensing means, for lateral engagement within the wire,

b. a servomechanism for operating said differential control means to steer the machine in dependence on said lateral-sensing means.

8. A machine as claimed in claim 1, wherein the slip forms are flared outwards at the rearward ends thereof to permit the machine to negotiate curves.

9. A machine as claimed in claim 1, further including a mechanism to adjust the height of the carriage relative to one-track unit to control the crossfall over the body of concrete.

10. A machine as claimed in claim 9 wherein said mechanism comprises:

a transverse axis on said mobile carriage;

a lever pivotally mounted on said transverse axis;

a frame for said one-track unit including a pivot for an end of said lever.

11. A machine as claimed in claim 1, further comprising a separate carrier for said sensing devices, suspended from said mobile carriage independently of said subframe but including coupling means coupling it to said subframe for displacement in unison therewith.

12. A machine as claimed in claim 11, said coupling means comprising a linkage pivoted to said mobile carriage.

13. A machine as claimed in claim 12, comprising a first pair of cranks supporting said carrier, a second pair of cranks supporting said subframe and a common shaft for both pairs of cranks journaled in bearings on the mobile carriage.

14. A machine as claimed in claim 11, wherein each sensing device includes:

a horizontal pivot axis;

a bar mounted on said pivot axis for displacement about a neutral position;

a magnet mounted on said bar;

and a magnetic switch operated at a predetermined displacement of said pivoted bar and attached magnet: and wherein each height-adjusting means is operated by a motor including a control circuit operated by said magnetic switch.

15. A machine as claimed in claim 14, wherein said horizontal pivot axis is oriented to enable the bar to respond to deviations of the angle of the machine with respect to a datum.

16. A machine as claimed in claim 14, wherein gravity-responsive means are provided to bias the bar to neutral position.

17. A machine as claimed in claim 14, wherein the bar has the pivot intermediate its ends and a magnet controlling a respective magnetic switch at each end.

18. A machine as claimed in claim 14 further comprising an arm projecting from the bar, a resilient follower for said datum wire on the free end of said arm, and a counterbalance weight on said bar to counteract any biasing torque due to the projecting feeler arm.

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