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(54) Apparatus and process for dowel insertion to concrete panel joints.

(57) A dowel insertion apparatus and process is disclosed for the insertion of a plurality of joining dowels between freshly poured and cured concrete panels. Each dowel (14) is grasped each by an individual inserter (17). Typically the inserter is mounted from a carrier and includes paired tangs (30) having female dowel receiving ends of arcuate configuration at the lower portion thereof which female arcuate ends precisely mate to and receive the dowels. These tangs are connected at a depth above maximum concrete penetration by an electromagnet (E). A vibrator (V) is attached to communicate vibrational energy to the inserter, this vibrator being chosen to have sufficient vibrational energy to fully liquefy the concrete. Dowel insertion includes positioning the paired tangs of each inserter over a steel and magnetic dowel, turning on the magnet and grasping a dowel by a precise fit at the female arcuate surfaces to the dowel. Thereafter, the dowel and inserter are positioned over a joint between two freshly poured concrete panels (10, 11). When insertion is to occur, the vibrators are turned on and the inserter lowered. Upon insertion to the concrete panel, the inserter and firmly grasped dowel liquefy the concrete in their downward passage and allow full depth penetration of the dowel in precise horizontal alignment to the referenced line and grade of the dowel insertion apparatus. At full

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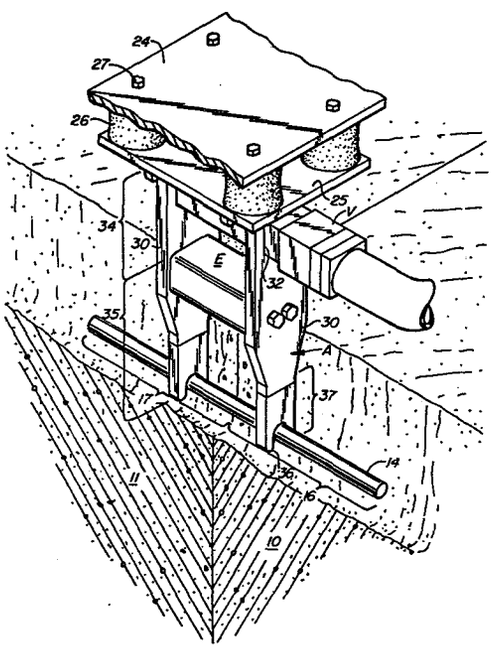

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depth, the vibrator is turned off and the dowel instantly becomes embedded in the freshly poured concrete as the lack of vibration solidifies the concrete relative to the dowel. When the inserter is withdrawn a short distance from the dowel, the vibration is recommenced with the vibrator fluidizing the concrete and filling any resultant voids. Vibration of the inserter continues until the inserter—at least in the vicinity of the female arcuate surface—is cleaned, such cleaning occurring by passage of the tangs over a wire brush. Upon withdrawal of the inserter at the downwardly protruding tangs, the finished surface of the concrete is substantially undisturbed. A dowel storage bin with distributing conveyor enables a row of inserters mounted to a carrier to distribute a plurality of dowels between two panels simultaneously, the dowels being evenly distributed the width of any expansion joint. A carrier for handling a group of correspondingly distributed inserters enables the disclosed mechanism to be operated off of a moving platform referenced to line and grade, such as a slip from paver, or on an independently mounted and moved frame. By synchronizing carrier movement so that speed relative to the ground is not present, dowel insertion along a joint after pouring can occur without disruption of paver movement.

APPARATUS AND PROCESS FOR DOWEL INSERTION TO CONCRETE PANEL JOINTS

This invention involves a method and apparatus for placing steel dowels between concrete panels within the expansion joint between concrete panels relatively immediately after panels are poured. By placing the dowels after the panels are poured, the dowels can be accurately located within the panels. There is provided a dependable, continuous, rapid, accurate, and economic method to distribute and place steel dowels in the transverse expansion between concrete panels without production delays.

Statement of the Problem

In concrete panels used for roadways and runways, placement of expansion joints is required. These expansion joints permit the concrete panels to shrink upon cure without the panels randomly cracking. Additionally and during the life of such roadway or runway panels, working occurs due to thermal expansion and contraction and normal flexure due to the passage of traveling loads, such as trucks and planes.

Typically, slabs are provided with expansion joints. These joints are formed to a depth that is in the order of one-third the thickness of the panel. The remaining portions of the panel crack in sympathy with the formed expansion joint along irregular boundaries that can be best described as mortise joints.

The juncture between panels at expansion joints has been the source of problems leading to even the destruction of the concrete panels. The panels at the mortise joints splay upon working one with respect to another, depositing portions of the panel within the joint itself. With the material accumulated inbetween the joints of the panels, expansion and contraction is not possible. As a result, whole panels bulge typically by moving upward at the joints and sagging in the middle.

Moreover, where there is any type of ground irregularity or uneven loading - as the passing of a heavy

wheel -- the panels work to differing elevations at their edges. To alleviate these effects, dowels placed in horizontal alignment in the direction of expansion and contraction are used between panels.

The dowels must be precisely placed. The dowels must have sufficient depth so that the concrete does not work or splay in the vicinity of the dowel placement. Moreover, they must be precisely horizontally aligned. This permits the panels to work towards and away from each other along the dowels but at the same time prevents the panels from changing their elevation relative to one another during such towards and away movement.

Imprecise dowel placement can be disastrous. Specifically, where dowels are aligned in a fashion that is other than horizontal and generally other than normal to the plane of the expansion joint, and more particularly where the dowels are skewed randomly out of a normal to the plane of the expansion joint, the expansion-contraction of the adjacent concrete panels eventually causes panel destruction. Specifically, side-by-side dowels skewed at random angles destroy the concrete panels from the edges commencing with the panel portion adjacent the dowel. Systematic panel destruction from the edges results.

Summary of the Prior Art

Heretofore, one practice for the placement of dowels has included placing dowels on "chairs" in the path of devices such as slip form paver. Specifically, the "chairs" rest on the ground and at an upper and elevated position hold and maintain dowels in alignment. Concrete is placed over the "chairs" with the joint being placed between the dowels. Numerous disadvantages are present.

Dowels mounted on chairs are time consuming to place. Moreover, the chairs are expensive; they must be sturdy enough to withstand concrete being placed and poured over them without having undue deflections so as to randomly skew the dowels. Additionally, the chairs are permanently lost. They become embedded in the concrete and form a portion of the resulting panel.

The placement of dowels between joints of abutted concrete panels has been attempted. However, the attempts heretofore have been unsuccessful for at least four reasons.

First, machines for the insertion of dowels have been displaced upwardly upon forced movement of the dowels down in and into the previously poured concrete panels. Moveover, such inserters have left openings behind the passage; the concrete has large holes or openings in and under the surface where the concrete has had the dowel inserted. Additionally, such openings have either been left latent -- in which case they vastly weaken the resulting concrete panel in the critical stress area of the expansion joint and the dowel -- or have inhomogeneously been filled with grout.

Regarding this filling of the panel with grout overlying the dowels, machines which place dowels have heretofore left imprinted in the freshly poured cementatious material at least indentations corresponding to the size and configuration of the dowel and the apparatus for placing the dowel. These machines have relied thereafter upon finishing beams to cover over and finish out these imprintations directly over the placed dowels. This reliance has been misplaced primarily because filling in of such imprintations occurs with grout.

Finishing beams in passing over poured and cured concrete depress large concrete particles (such as aggregate and the like) in their paths of travel and accumulate the concrete fines (a mixture of sand, small gravels and cement known as grout) in their path of travel. This accumulated grout typically precedes a finishing beam and readily fills the indentations caused by the placement of dowels.

Unfortunately grout does not have the strength and is not homogeneous with concrete including the aggregate. Therefore, grout-filled imprintations directly over dowels constitute points of weakness.

This problem compounds itself. Specifically, the area of joinder or working of a dowel to a concrete panel constitutes a relatively high stress area of a concrete

panel. To have a grout-filled area of weakened strength immediately overlying such a dowel can constitute a serious structural weakness.

Dowels placed by vibrating arms mechanically gripping the dowels are known. Heretofore, such machines for the automatic insertion of dowels have had numerous disadvantages.

First, their heads for mechanically gripping the dowels have been of large dimension. These heads in extending into the concrete leave in their wake large displaced areas and depressions, which areas and depressions become subsequently filled with grout.

Secondly, the dowels are literally forced into the ground. Upon such forcing into the ground, reactive forces cause displacement of the platform from which they are placed. Reference to line and grade is lost. Where the platform from which placement occurs is a slip form, disturbance of the entire concrete panel can result.

Additionally, the dowels themselves being forced into the concrete do not necessarily bond the concrete in a homogeneous fashion. As the concrete is physically displaced in the path of the dowel (instead of being in effect liquefied), dowel joinder to the cured concrete panel is uncertain.

One of the major shortcomings of machines that have attempted to place dowels into concrete has been the failure to provide shock buffering capacity between the vibrating inserter and the machine or platform on which it is supported and actuated. Where vibrational isolation or insulation is not present, vibrational energy is needlessly and sometimes destructively communicated from the machine to the platform from which dowel placement occurs. Moreover, the vibrational energy is not confined to the inserter. Indeed, in concrete mixtures of low slump, placement of dowels by machine has only occurred with moderate success.

The reader will recognize that identifying the problem related to the prior art is ofttimes the equivalent of invention. It will be understood that in recognizing the

failure of the prior art to adequately isolate vibration, I claim invention over the prior art.

Summary of the Invention

A dowel insertion apparatus and process is disclosed for the insertion of a plurality of joining dowels between freshly poured and cured concrete panels. Each dowel is grasped each by an individual inserter. Typically the inserter is mounted from a carrier and includes paired tangs having female dowel receiving ends of arcuate configuration at the lower portion thereof which female arcuate ends precisely mate to and receive the dowels. These tangs are connected at a depth above maximum concrete penetration by an electromagnet. A vibrator is attached to communicate vibrational energy to the inserter, this vibrator being chosen to have sufficient vibrational energy to fully liquefy the concrete. Dowel insertion includes positioning the paired tangs of each inserter over a steel and magnetic dowel, turning on the magnet and grasping a dowel by a precise fit at the female arcuate surfaces to the dowel. Thereafter, the dowel and inserter are positioned over a joint between two freshly poured concrete panels. When insertion is to occur, the vibrators are turned on and the inserter lowered. Upon insertion to the concrete panel, the inserter and firmly grasped dowel liquefy the concrete in their downward passage and allow full depth penetration of the dowel in precise horizontal alignment to the referenced line and grade of the dowel insertion apparatus. At full depth, the vibrator is turned off and the dowel instantly becomes embedded in the freshly poured concrete as the lack of vibration solidifies the concrete relative to the dowel. When the inserter is withdrawn a short distance from the dowel, the vibration is recommenced with the vibrator fluidizing the concrete and filling any resultant voids. Vibration of the inserter continues until the inserter—at least in the vicinity of the female arcuate surface—is cleaned, such cleaning occurring by passage of the tangs over a wire brush. Upon withdrawal of the inserter at the downwardly protruding tangs, the finished

surface of the concrete is substantially undisturbed. A dowel storage bin with distributing conveyor enables a row of inserters mounted to a carrier to distribute a plurality of dowels between two panels simultaneously, the dowels being evenly distributed the width of any expansion joint. A carrier for handling a group of correspondingly distributed inserters enables the disclosed mechanism to be operated off of a moving platform referenced to line and grade, such as a slip form paver, or on an independently mounted and moved frame. By synchronizing carrier movement so that speed relative to the ground is not present, dowel insertion along a joint after pouring can occur without disruption of paver movement.

Objects, Features and Advantages

An object of this invention is to disclose an apparatus for the insertion of steel dowels between freshly poured concrete panels at an expansion joint. According to this aspect of the invention, an inserter is disclosed including paired tangs extending downwardly with a lower extremity including a rounded female arcuate surface for extending over and onto and precisely joining to a dowel. The tangs are interconnected by a magnet. Preferably, the tangs consist of a non-magnetic steel above the magnets. This causes energizing of the magnet when the tangs are in contact with a dowel to complete a magnetic circuit to firmly grasping the dowel. The inserter has a vibrator for generating vibrational energy sufficient to liquefy the concrete into which the tangs and dowel are inserted. At an area between the inserter and any platform from which it is operated, a resilient mounting is placed. This mounting serves to isolate vibrational energy of the vibrator to the inserter and prevent vibrational energy from being lost by needlessly and ofttimes destructively vibrating the platform to which the inserters are attached.

The magnet is isolated in its magnetic circuit from the vibrator. An advantage of isolating the magnetic circuit away from the vibrator is that the vibrator bearings do not have a magnetic field communicated to them. Conse-

quently, magnetic particles drawn to the bearings are avoided. Bearing races do not suffer the high and abrading wear rate of bearings with magnetic particles drawn thereto.

An advantage of the disclosed rod-inserter and vibrator unit is that precise alignment and placement of dowels can occur. The dowels are located accurately with respect to grade and line by manipulation of the inserter.

Yet another advantage of the inserter is that the prior art practice of placement of the dowels with a "chair" is avoided. A time consuming and expensive placement of "chairs" before panel curing is avoided.

An additional object of this invention is to disclose a dowel inserter which can be modified to meet varying specifications for the placement of dowels. According to this aspect of the invention, the concrete penetrating tangs are welded to the inserters to fit the specifications of each job. Specifically, they are given a length so that required elevational insertion from line and grade is accommodated. Moreover, individual inserters are given variable side to side spacing so that the specified side to side spacing between dowels is likewise accommodated. In short, simple machine modification before a job enables high productivity once paving is commenced.

Yet another advantage of the inserter of my invention is that it can be individually removed, serviced and replaced. Consequently, repair of inserters damaged at their vibrators or magnets is possible. Moreover, downtime of the dowel inserting machine is maintained at a minimum.

Yet another object of this invention is to disclose a process for dowel placement using the disclosed inserter. According to this aspect of the invention, the inserter is first placed over and onto a dowel and the magnet energized. The resulting closed magnetic circuit including the dowel causes the dowel to be firmly grasped. The inserter and dowel are then placed over a previously and freshly poured joint area between two concrete panels. Immediately prior to dowel insertion, the vibrator is turned on. The concrete is liquefied in the path of the dowel and

inserter as the dowel is inserted to and passes to its desired full depth. Once the dowel is at depth, the vibrator and magnet are turned off. Concrete solidifies about the dowel immediately embedding the dowel. Thereafter the inserter is retracted a small distance before the vibrator is reactivated. When the vibrator is reactivated only the concrete in the immediate vicinity of the inserter tangs is fluidized. Consequently, upon retraction of the inserter, any holes which form about the penetration of the inserters are refilled. The surface of the panel is generally restored.

An advantage of the disclosed process is that immediately prior to lowering of the dowels, their positioning relative to the joint area between two adjacent concrete panels can be visually checked. Precise dowel placement results. Placement of a panel joint over "chair" supported dowels previously placed but hidden by poured concrete is not required.

A further advantage of the disclosed process is that the concrete is fluidized during dowel insertion. Consequently, reactive forces on the inserters are minimized. Where the machine is mounted to slip form apparatus, undue displacement of the slip form and corresponding deformation of the panel does not occur. Where the inserter is mounted to an independent frame unit, movement of the frame from supporting tracks or wheels does not occur.

Yet another advantage of the disclosed process is that during the insertion of the dowel, the concrete placed is not classified into grout and aggregate components or otherwise appreciably disturbed. Consequently, the rod joined to the panel is fully capable of accommodating the designed expansion and contraction. Areas of panel weakness do not exist on, in, above or about the dowel.

Still another advantage of the disclosed process is that once the rod is at the desired depth and the vibration stopped, instant solidification of the concrete about the rod occurs. Consequently, the rod is immediately embedded into the surrounding concrete. Retraction of the

placing tangs from the rod can occur with a minimum of disturbance.

Yet a further advantage of the disclosed process is that after the forks are free of the dowels but before they are completely withdrawn from the concrete, the vibration is reactivated. This vibration fluidizes the concrete immediate the tangs but does not affect the concrete immediate the dowel. Consequently, the concrete tends to flow and replace any void created by the inserting forks. Vibration is not stopped until the inserting forks are free of the freshly poured panel.

A further advantage of the disclosed process is that the concrete is maintained in a homogeneous panel in and around the inserted dowel. The disclosed vibrating and fluidizing process does not classify or segregate constituents of the concrete. It does not leave void in the concrete. Moreover, the accumulation of grout above the inserted dowel does not occur.

A further advantage of the apparatus and process herein disclosed is that dowel insertion occurs into freshly poured concrete panel and not ahead or in the path of concrete paving machinery. In many instances, the front or the sides of concrete paving machinery become otherwise occupied as large quantities of concrete to service automated pavers must be brought in in these areas. Indeed, some roadways are built in areas of restricted access where only the front portion of the paver is accessible. Here, however, dowels are not required to be placed in front of the paver. Instead dowels are inserted to the rear of the machine. Production convenience in dowel insertion is achieved.

A further object of this invention is to provide for the insertion of dowels in mass across a joint between two concrete panels. According to this aspect of the invention, a magazine loaded with rods is discharged to a chain conveyor having a plurality of stations thereacross. The conveyor receives and spaces dowels in anticipation of the dowels being picked up by correspondingly spaced inserters. When the conveyor has precisely positioned the dowels, the

inserters, correspondingly precisely positioned, grasp the rod through contact and thereafter activation of the inserter magnets.

An advantage of this aspect of the invention is that the disclosed apparatus can be made the width of poured concrete panels. By variation of the spacing on the conveyor and corresponding variation of the spacing between inserters, varying rod dimensions and spacing can be accommodating.

The reader will remember that I have utilized resilient mountings for the inserters of this invention. As a side benefit of the resilient inserters that I utilize, I now am able to convey dowels into precise position for pickup by inserters having the same corresponding precise position. Vibrational energy is not communicated to my conveyor. Consequently, dowels on my inserters do not "walk" or vibrate out of position; they remain precisely positioned so that remote handling is possible.

Yet another object of this invention is to disclose a hydraulically actuated carriage for operating a plurality of inserters. According to this aspect of the invention, the carriage operates during rod insertion to maintain a stationary position over a joint between two panels. At the same time, the carriage is operating from a moving frame referenced to line and grade, such as a slip form for the placement of concrete. There results a placement of dowels across the area of an expansion joint from a moving platform without interruption of the progress of work.

An advantage of this aspect of the invention is that production of a slip form paver is not interrupted. Periodic stopping and starting of the paver are not required.

A further advantage of this apparatus is that the disclosed apparatus can be mounted relative to or independent of a paver. For example, it can be mounted on its own separate frame which may either be intermittently positioned

for dowel placement or continuously moved so long as reference to grade and line is maintained.

Other objects, features and advantage of this invention will become more apparent after referring to the following drawings and attached specifications in which:

Fig. 1 is a perspective view of a single inserter according to this invention;

Fig. 2 is a perspective view of a conveyor for conveying rods into positions for grasping by a plurality of inserters, the conveyor here being shown connected to a magazine;

Fig. 3 is a perspective view of a matrix of inserters mounted for picking up and thereafter inserting a group of rods; and

Figs. 4A - 4G are a cartoon series illustrating a slip form concrete paving machine operating in cycle with the dowel inserter of this invention.

Fig. 5A is a perspective view of the rod release mechanism of this invention at the bottom of the conveyor;

Figs. 5B, 5C and 5D are a cartoon series in side elevation section illustrating the release of rods according to this invention.

Referring to Fig. 1, rod inserter A of this invention is shown in perspective overlying concrete slabs 10 and 11 with dowel 14 extending across an expansion joint area between the panels. The reader will realize that the expansion joint has not been yet placed. The expansion joint is only schematically shown so that placement of the dowel in the panel across the joint is fully understood.

Typically, one portion 16 of the dowel 14 is greased, painted or otherwise coated. the remaining portion 17 of the dowel 14 is not coated. Curing of the concrete causes portions 17 of dowel to key to slab 10. The coated portion of the dowel 11 is free to work in expansion and contraction when either curing contraction or thermal expansion and/or loading results in expansion joint flexure.

It is important that dowel 14 be normal to the plane of the expansion joint between the slabs 10, 11. Thus

toward and away expansion can be accommodated without the destruction of the panels from the edges as previously described.

It will be realized that should a group of dowels 14 be randomly skewed, working of the two slabs 10 and 11 would change the spacial distances between the slabs at the points of dowel joinder. Slabs 10 and 11 would chip and splay at their edges resulting in reduced panel life.

In the portion of the description that follows, the construction of a single dowel inserter will first be set forth. Thereafter, a conveyor for dispersing a group of rods will be described. Then the construction of group inserters for grasping and thereafter inserting the dowels between freshly poured panels will be set forth. Finally and with reference to a cartoon series of drawings, the discrete steps in the dowel inserting process will be set forth.

Dowel Inserter

A typical dowel inserter A includes inserter support bar 24 dependingly supporting individual inserter support plate 25. Typically four rubber shock isolaters 26 concentrically mounted to bolts 27 support plate 25 from plate 24. Isolaters 26 insulate the vibration of vibrator V from the support 24 so that the vibrational energy of the hydraulic vibrator can be usefully confined to the vicinity of the inserter. As hereinbefore set forth, the failure to install insulators has resulted in failure of the prior art devices.

Support plate 25 has conventionally joined two tangs 30. Tangs 30 at the upper end thereof define a square aperture 32 into which vibrator V is received. Aperture 32 has mounted thereto clamps such that vibrator V is firmly captured therein so the vibrational energy is readily transferred to the tangs 30.

An electromagnet E is mounted between tangs 30. Fabrication and installation of this electromagnet is not trivial.

First, the electromagnet is fabricated so there is no relative movement between any of the parts of the electromagnet and the two tangs 30 to which it is braced and cross connected. As is apparent, the vibrator V will literally destroy the electromagnet E in case any portion of the magnet comes free from the entire assembly and begins to vibrate.

Secondly, the electromagnet in the vicinity of its fastening to the respective tang 30 is securely mounted. Relative movement between the electromagnet E and its point of mounting not only causes failure of the magnet to communicate its magnetic field to the tangs 30, but additionally also effectively destroys the magnet.

Each of the arms 30 has a magnetic portion 34 and non-magnetic portion 35. Non-magnetic portion 35 can be seen to terminate just above magnet E. This non-magnetic portion 34 prevents the field of the electromagnetic from being communicated upwardly to the inserter support plate 25. Magnetic portion 34 of the tang enables the field of the magnet to be communicated down to and towards the bottom portion of the tangs 35. When a magnetic circuit is completed between the lower portions of the two tangs, as by a dowel contacting the tangs, the magnetic circuit is completed and the dowel is firmly held and grasped in place.

The isolation of the magnetic field from electromagnet E from portion 34 of the inserter has an additional advantage. Typically, the vibrator V comprises an eccentrically weighted shaft mounted to bearings. The shaft is in turn driven by a motor, the motor here being shown as hydraulic. Electric motors can be used as well.

Should the magnetic field from the electromagnet E be accumulated to the vibrator, reduced vibrator life can result. I have found that any metallic particles present in or near the vibrator will be drawn to and accumulated within the vibrator bearings. Such accumulation causes rapid abrading wear of the vibrator. There results a vastly reduced vibrator life.

It will be noted that the lower end of each of the tangs 30 is provided with a rounded section 36. Rounded section 36 is configured to extend up and over a dowel. This half-round aperture is flaired so that when the inserter A comes down over a dowel 14, a gathering of the dowel to a central position occurs.

The half-rounded or arcuate portion of the tangs must be configured to precisely fit over the dowel 14. Anything less than a precise fit will not allow the vibrational energy of the vibrator V to be communicated to the dowel 14.

Additionally, the tangs at lower portion 38 must be of sufficient length to permit dowel penetration into the slab. Consequently, the lower portion of the arms 38 are usually tailored to the specific construction being undertaken by the dowel inserter. In actual practice, they are welded in place, used for a particular job, and thereafter cut off and replaced. As those skilled in the art are aware, tailoring of the machine for a particular job is desirable.

Additionally, the lower portion of the arms 38 is provided with a relatively constant cross section. This lower portion 38 has the greatest penetration into the slab.

Having set forth the construction of the inserter, attention will now be directed to the conveyor mechanism for disposing bars for pick-up and a support for a multitude of inserters. The views of Figs. 2 and 3 will be used.

Conveyor

Referring to Fig. 2, a magazine of cylindrical rods is illustrated having an angularly sloping section 40 extending to a vertical section 42. As can be seen, the rods are confined in single file down to a feed mechanism 43.

Sloping section 41 typically has rods 14 placed therein sufficient to constitute a complete joinder across a concrete panel. Once the rods 14 are loaded in section 40 they are released by a release handle 39. Upon release at the release handle 39, they travel en masse down to vertical

section 42. At vertical section 42 they are held until released by the conveyor mechanism.

Feed mechanism 43 includes a spring loaded arm 44 maintaining each of the individual rods 14 over paired traveling endless chain belts 46. Endless chain belts have pawls 47 and keeper bars 48 sequentially fastened thereto.

In operation, keeper bars 48 pass under a rod 14 at the bottom of vertical section 42. Pawls 47 dislodge rod 14 and pivot the spring 44 out of the way. Typically, chains 46 continue movement until a limit switch 49 detects the presence of a dowel at the end of the conveyed path. The endless chains then stop.

It will be therefore be seen that the dowels are distributed at even spatial intervals fully along the length of the conveyor. It is in this disposition that they are picked up by a group of inserters A as illustrated in Fig. 3.

Referring to Figs. 5A and 5B, the process of insertion and dispensing of the individual rods 14 to the conveyor may be understood. A vertical channel 100 conveys the rods single file to a dispenser. A block 101 holds the dispensed rods free and clear of the passing chain 46, the pawl 47 and the keeper bar 48. As can be seen, the bottom-most bar 14 is biased to and toward the direction of travel of the chain with a spring-loaded retainer bar 101 stopping the respective bars from falling out in an unlimited number on the surface of the chain 46. It will be noted that vertical channel 101 is provided with a forwardly angled backpiece 102.

Referring to Fig. 5C, it can be seen that retainer bar 48 passes under the bars 14 and that pawl 47 dislodges the bars 14. This dislodgment occurs against the pivoting retainer bar 101. Finally, and in the sequence of Fig. 5D, it is seen that the chain 46 causes the bar 14 as followed by pawl 47 to be dispensed on the chain while the next in order dowel 14 is held in place by pivoting retainer bar 101. Thus, the sequence of dispensing of the bars can easily be understood.

Group Mounting of Inserters

The inserters A can take a number of different embodiments. Such a differing embodiment is illustrated in the view of Fig. 3.

Referring to Fig. 3, beam 63 has extended on either side thereof respective support plates 64, 65. Support plates in turn dependingly support a support beam 66. Support beam 66 is mounted from plates 64, 65 by a group of isolaters, there being approximately 6 isolaters for the support of five inserters A. On either side of support beam 66 at preselected intervals there are fastened vibrators V. These vibrators are electric and have an electric drive motor. They are Minnick "H1200" vibrators and are here shown in opposition one to another to impart the necessary vibrations to a group of inserters A's. As illustrated here, four such vibrators vibrate five inserters A.

The amount of vibrational energy communicated to the rod inserters is important. Specifically, and dependent upon the slump of the concrete, vibrational energy of varying amounts will be required. I have found for example that where the slump is low -- in the range of 1/4 inch to one inch, high vibrational energy is preferred. In this case, I use the inserter of Fig. 1. In this case, the vibrator is installed to each inserter such relatively low slump concrete is commonly used on airport runways and European highways.

Where, however, the slump is greater, as in the installation of domestic highways in the United States, lower vibrational energy can be used. In these embodiments, vibrators according to those illustrated in Fig. 3 can be used.

The reader will also understand that concrete is never constant in its constituent mix. Consequently, everything about concrete is variable. Precisely quantifying the amount of vibrational energy to liquefy the concrete is not practical or possible. Hence the vibrators utilized with the inserters of this invention should be variable in their

energy output. They should always be able to supply sufficient energy to liquefy of the concrete as the dowels and inserters progress their way down through the slab to the point of rod insertion.

The construction of inserters A is similar. Specifically, the inserters have magnetic portions 68 with an electromagnet E therebetween. Small stainless steel sections 69 at the top of magnetic portions 68 confine the magnetic path down the respective arms 68 and across any dowels 14 that are held by the unit. By the expedient of matching the interstitial spacing between the inserters A equivalent to the interstitial spacing between the dowels 14 disposed on the endless belt 46, it will be seen that a group of dowels may be picked up by an assembly of inserters A as illustrated in Fig. 3.

Having set forth the construction of the conveyor and the group of inserters, attention can now be directed to the process of insertion.

Process of Insertion

Referring to Fig. 4A, a slip form paver 100 having an finishing beam 101 is shown progressively applying concrete 102 between a grade level 103 and the slipping form 104. As is common in the construction industry, the machine is furnished with means that give the slipping form 104 and all other portions of the machine a reference to grade and line.

It will be understood that the dowel inserting invention can be mounted to any number of mechanisms and that the invention is not confined to the slip form paver here illustrated. Indeed any machine which rides on rails over freshly poured and uncured concrete panels will supply a sufficient platform. It is necessary that the machine be provided with adequate reference to line and grade.

Continuing on with the views of Figs. 3 and 4A, three mechanisms attached for the group of inserters A are necessary.

First, the group of inserters must be mounted to a frame mounted railway 105 at a moving car 104 (only shown

schematically in Fig. 3). This enables the car 104 to slide back and forth overlying the concrete panels.

Secondly, some means for moving the car 104 on the railway must be present. Here, hydraulic cylinder 107 is utilized. Cylinder 107 causes the car to slide forwardly and backwardly.

Thirdly, some means of moving the group of inserters A into and out of the concrete pavement must be present. A cylinder 109 is here shown causing movement of the inserters A into and out of the pavement.

Movement occurs on a vertical railway 106 (see Fig. 3). Wire brush 110 is present. The wire brush causes the ends of inserters A to be cleaned immediately after retraction from the freshly poured concrete.

Setting forth the status of the machine cycle as shown in Fig. 4A can be instructive. Specifically, the endless belt 46 has disposed a group of rods 14 for pick-up. The electromagnetic across each of the inserters has been turned on and the inserters have come down on and over the respective dowels 14. At this particular time the vibrators are off. Dowels 14 have been slightly elevated by the inserters.

Referring to Fig. 2, and underlying each rod 14 as positioned on the conveyor, there will be seen to be resilient pads 38. It will be appreciated that hydraulic cylinders such as cylinders 109 typically have a slight overstroke. Once such an overstroke is present, tangs 30 must be able to grip their respective rods 14 without causing rod or conveyor breakage. Resilient pads 38 permit this overstroke to exist without causing machine failure.

Referring to Fig. 4B, slabs 10, 11 are shown with an expansion joint area 15 therebetween. Hydraulic cylinder 107 has commenced to expand so as to maintain car 104 stationary over the expansion joint area 15 between slabs 10, 11, it being realized that the expansion joint will not be installed until after the rods are inserted. The dowels 14 are held by the inserter A immediately over the joint area 15. Note that at this juncture, it is pos-

sible for observation of the dowels relative to the expansion joint area 15 to occur.

Referring to Fig. 4C, the inserters A will have lowered the dowels 14 across the expansion joint 15 between slabs 10, 11. The magnets E will remain on and the vibrator V will be turned on immediately before insertion commences. Typically, the three stage cylinder 107 is released and the carriage allowed to freely wheel along the railway 105 so that there is no relative movement between the group of inserters A and the passing concrete slabs 10, 11.

It is important to note that the vibrational energy imparted has the effect of fluidizing the concrete. Specifically, the concrete is fluidized in and around the rod 14 and the inserter A. Thus the dowel freely passes into and through the freshly poured concrete slab along a full fluidized path. The respective solid and fluid areas are dominated on the drawing and only illustrative of the state of the slab when dowel 14 has arrived at its full depth of penetration.

Insertion in actual practice occurs to a depth as required by specification for a particular job. By way of example insertion could be approximately half of the slab width, in the illustrated case in the order of five inches of a ten inch slab.

It is an important aspect of this invention that the disclosed vibrations do not interfere with the slab. In fact, the apparatus and process leaves the surface of the slab substantially undisturbed and does not effect or classify either the aggregate, cement or sand constituents of the concrete.

Referring to Fig. 4D, retraction of the inserters A is illustrated. In the sequence, the dowels 14 are placed. The magnet is turned off and the retractors moved a small distance. Thereafter when the tangs of the retractors clear the dowels, the vibrators are restarted.

It is at this juncture that the process has some rather subtle features. Once vibration is ceased and the dowel 14 released, what was a relatively fluidized concrete

mixture becomes immediately solidified. The dowel 14 is captured by the concrete mass in precisely the alignment it had when the vibratoin ceased. Naturally and when the electromagnetic force which maintains the dowel to the inserter is turned off, retraction of the inserter A leaves the dowel 14 firmly and accurately embedded within the concrete.

It is to be noted over the prior art chair mechanism that it is the dowel that is inserted to the pre-existing slab of concrete. It is not the concrete being poured around the dowel. There results a dowel 14 which can only be maintained in the concrete in the disposition it was placed.

Further, and after the inserters A have cleared the dowel 14 by even a small distance, vibration is recommenced. At this juncture, the inserter A fluidizes the concrete about its respective arms. The concrete therefore flows and occupies the volume occupied by the inserter as it is withdrawn. In short, fluidized concrete fills into the path of the withdrawn inserter.

Referring to Fig. 4F, cylinder 107 is shown with drawing carriage 104 and inserters A over the wire brush 110. Wire brush 110 cleans the bottom of the inserters of any cement or grout that may remain thereon and enables a clean metal-to-metal contact to occur when the next rods are picked up. At the same time, the oscillating finishing beam 101 finishes over the surface of the concrete. Any blemish left in the slab by the withdrawal of the inserters A is avoided.

It is preferred to leave the vibrators on during the wire brushing of the concrete. It will be remembered that the vibrators function to fluidize the concrete. Concrete on the bottom of the tangs 30 will be fluidized also. In the fluidized states, the wire brushing has the maximum cleaning effect.

After the tangs have been wire-brushed, the vibrators and the electromagnets are both off. The sequence is then restarted.

It will be apparent having skill in the arts that this invention will admit of a number of modifications. Morover, the precise sequence of electromagnetic controls and the like are believed to be well within the skill of those ordinarily acquainted with the art.

What is claimed is:

1. Apparatus for the insertions of dowels between expansion joints of freshly poured concrete panels comprising in combination: at least one arm for inserting a dowel into a concrete panel, said arm having a lower dowel receiving concavity; means for retaining said dowel to said arm before insertion of said dowel within said panel; means for urging said dowel and arm into said freshly poured concrete panel; and, means for vibrating said dowel during insertion, said vibrating means having sufficient energy to fluidize said freshly poured concrete during said insertion; and, a vibration isolator, said dowel arm mounted to said vibration isolator for isolating vibrations to said dowel and dowel arm.

2. The invention of claim 1 and including in combination first and second dowel arms for inserting a dowel into a concrete panel.

3. The invention of claim 2 and including first and second magnetic dowel arms for inserting a dowel into said concrete panels; and where said means for retaining includes magnet means extending between said dowel arms whereby said dowel and arm forms a magnetic circuit to retain said dowel to said arms.

4. The invention of claim 3 and wherein said two arms include non-magnetic portions to confine the energy of said electromagnet to and between said arms for firmly grasping said dowel.

5. Apparatus for the insertion of dowels between expansion joints of freshly poured concrete panels comprising in combination: a frame means for supporting said frame at a constant elevation with respect to line and grade over a freshly poured concrete panel; a dowel inserter including first and second dowel arms for inserting a dowel into a concrete panel, means for retaining said dowel to said dowel arms before insertion of said dowel within and across said concrete panels; means for urging said dowel arms and dowel into said freshly poured concrete panel; means for vibrating said dowel arms and attached dowel during insertions of said

dowel to said panel, said vibrating means having sufficient energy to fluidize freshly poured concrete during said insertion of vibration isolator means between said dowel arms and supporting frame for isolating the vibrational energy of said vibrating means to said inserter.

6. The invention of claim 5 and wherein said first and second dowel arms are magnetic and said means for retaining said dowel to said arm comprises an electromagnet extending between said arms for forming a magnetic circuit when said dowel is attached to said arms.

7. The invention of claim 6 and including a plurality of side-by-side pairs of dowels receiving arms fixed to said frame in spaced apart relation.

8. Apparatus for the insertion of the plurality of dowels between an expansion joint extending between two freshly poured and cured concrete panels, said apparatus comprising in combination: a support frame supported with respect to line and grade over freshly poured concrete panels; a plurality of dowel arms supported in spaced apart predetermined intervals across said panels for disposing a group of dowels transverse of the expansion joint between said panels; each dowel arm for inserting a dowel into said concrete panels across said expansion joint, means for retaining dowels to said dowel arms; means for urging said arms and dowels to a concrete panel; means for vibrating said dowel arms and dowels during insertion, said vibrating means having sufficient energy to fluidize said freshly poured concrete during insertion; means for isolating vibrational energy to said inserters; means for maintaining said frame and depending dowel arms stationary with respect to said concrete panels during insertions; and means for finishing said panels after insertion.

9. Appartus according to claim 8 and wherein said retaining means includes electromagnets.

10. Apparatus according to claim 8 and wherein said means for maintaining said frame and depending dowel arm stationary includes means permitting said frame to move freely on said support frame.

11. Apparatus according to claim 8 and including cleaning means for said dowel support arms.

12. A process for the insertion of a dowel to at least one freshly poured concrete panel comprising the steps of: providing at least one arm for grasping and inserting a dowel to a freshly poured concrete panel; grasping a dowel at said arm; inserting said dowel with said arm; during said inserting step vibrating said arm with sufficient energy to fluidize concrete adjacent said arm dowel; releasing said arm in said panel; and withdrawing said arm from said dowel and panel whereby said dowel becomes embedded within said arm and freshly poured concrete in contact with said arm is fluidized to replace the void of said arm during said withdrawal.

13. The invention of claim 9 and including the step of ceasing said vibration during the release of said dowel.

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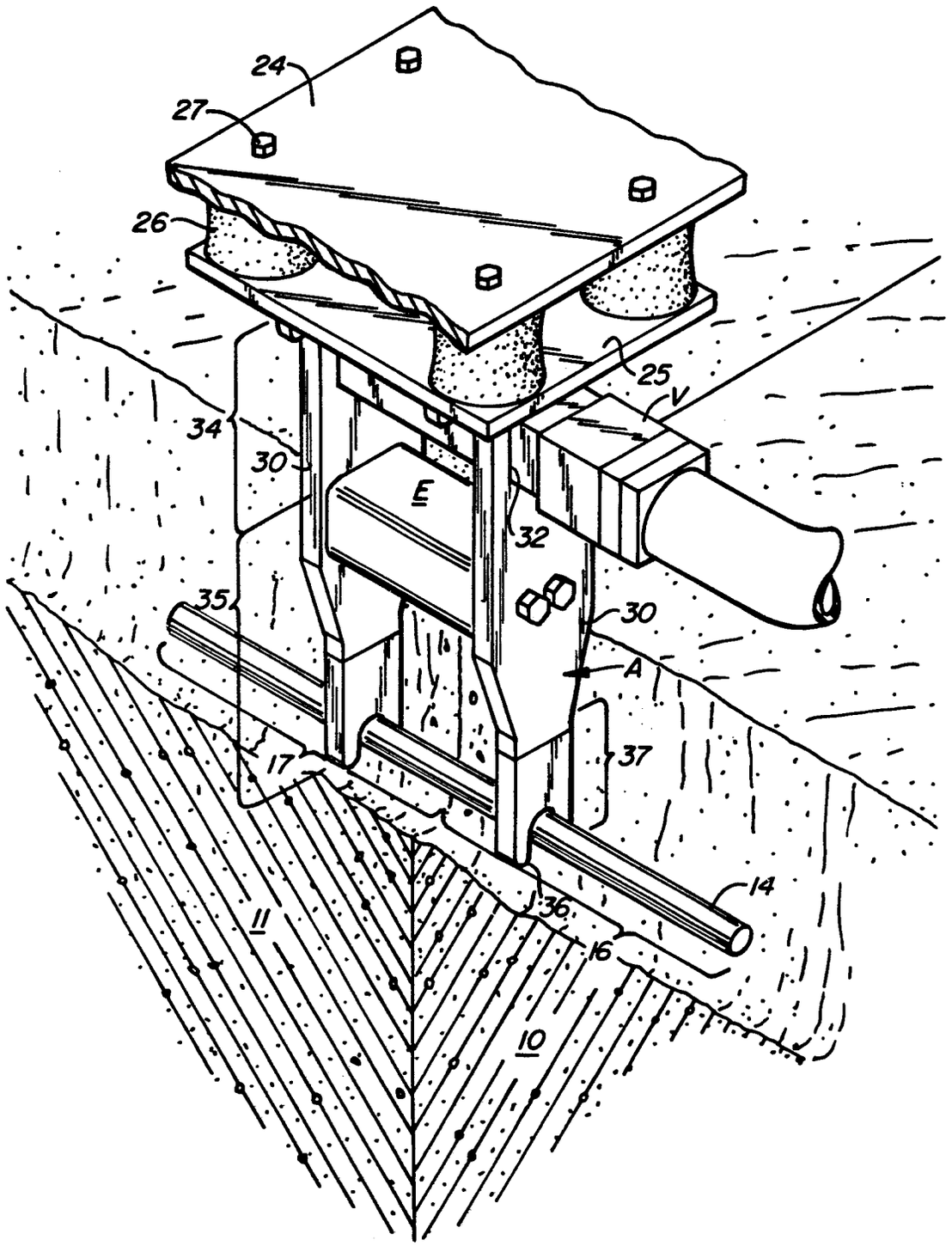

FIG. 1.

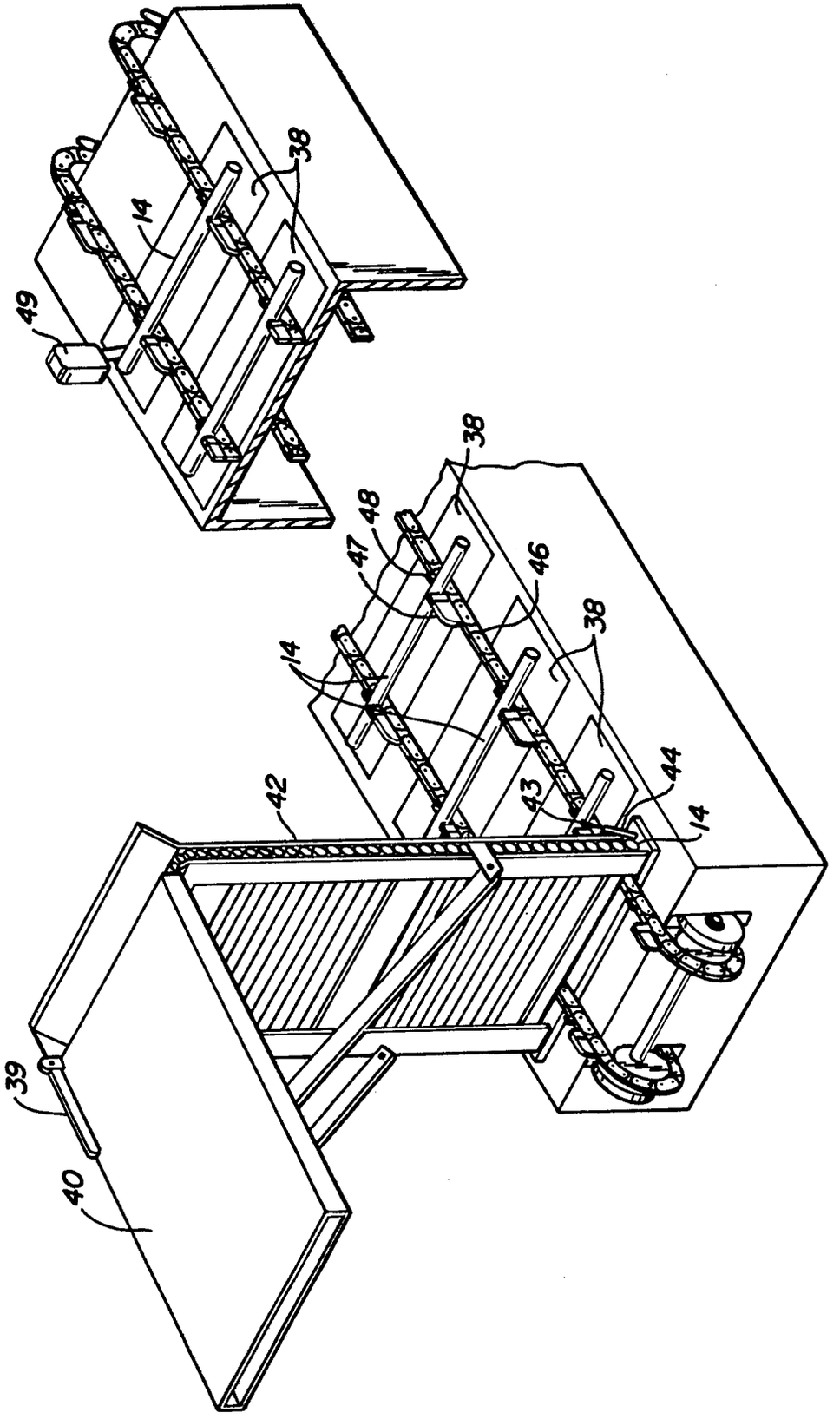

FIG. 2.

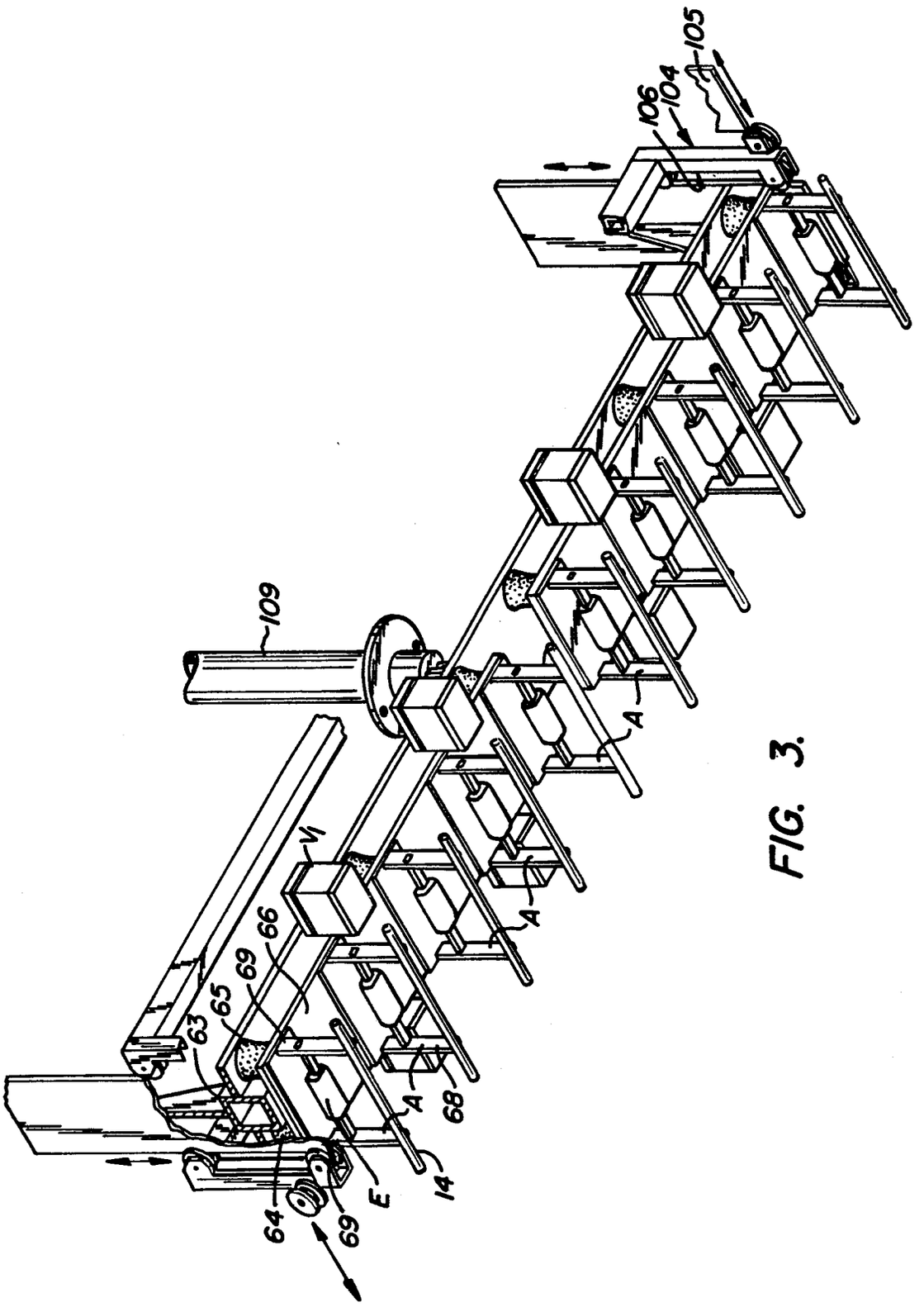

FIG. 3.

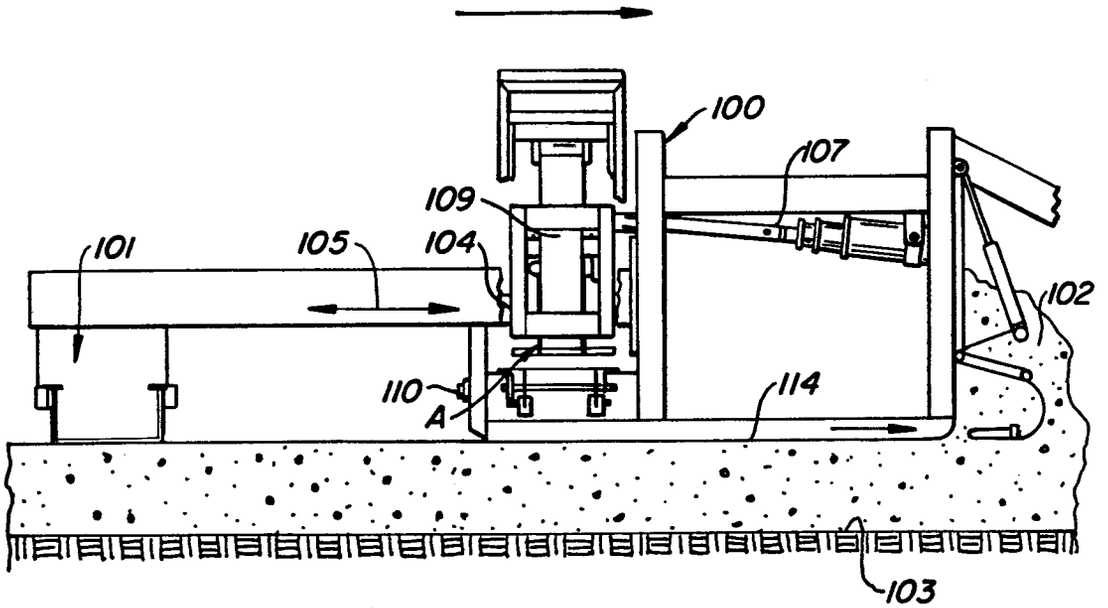

FIG. 4A.

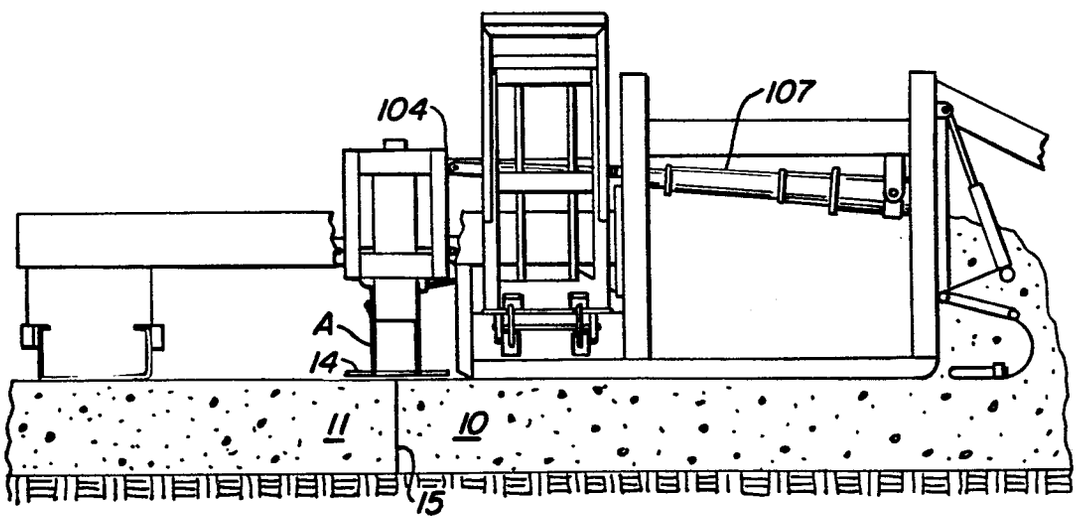

FIG. 4B.

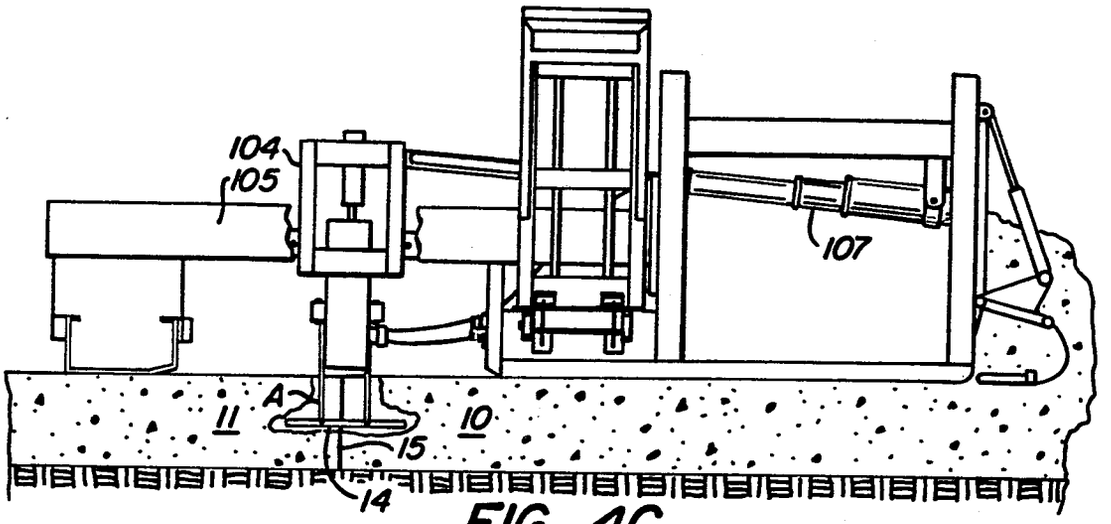

FIG. 4C.

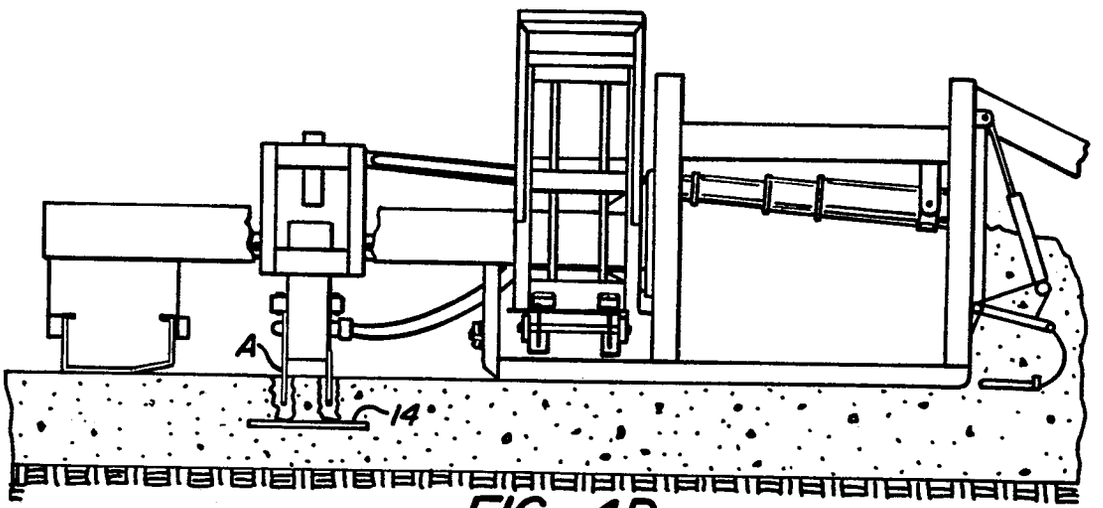

FIG. 4D.

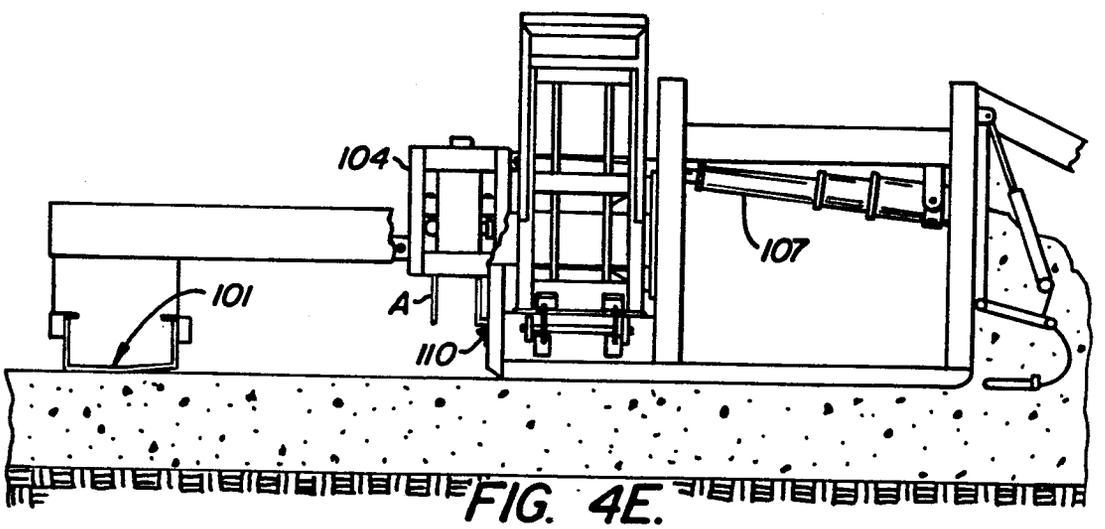

FIG. 4E.

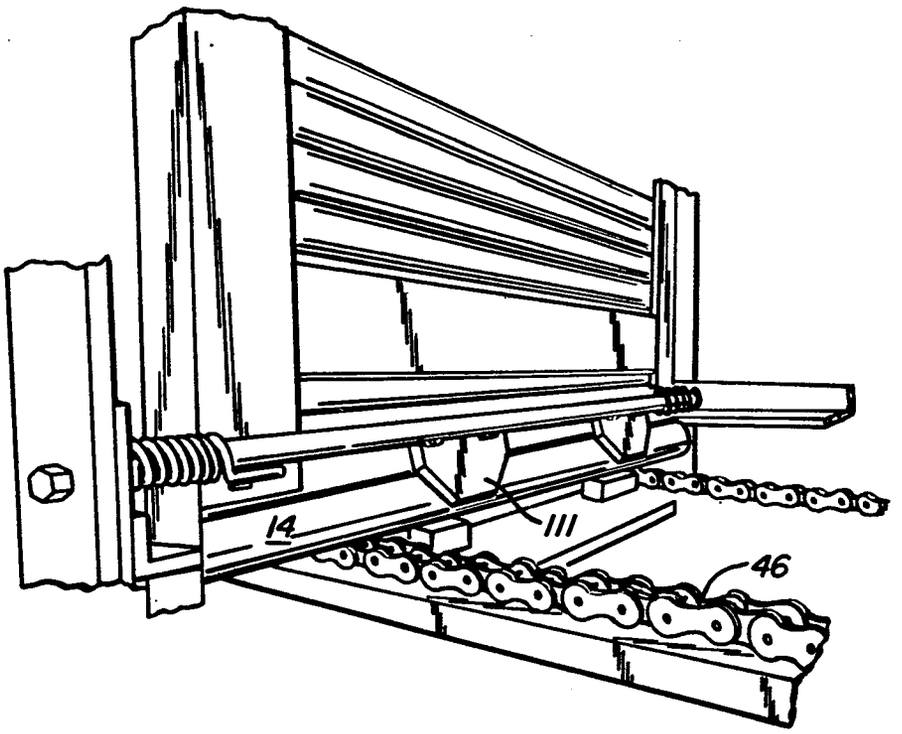

FIG. 5A.

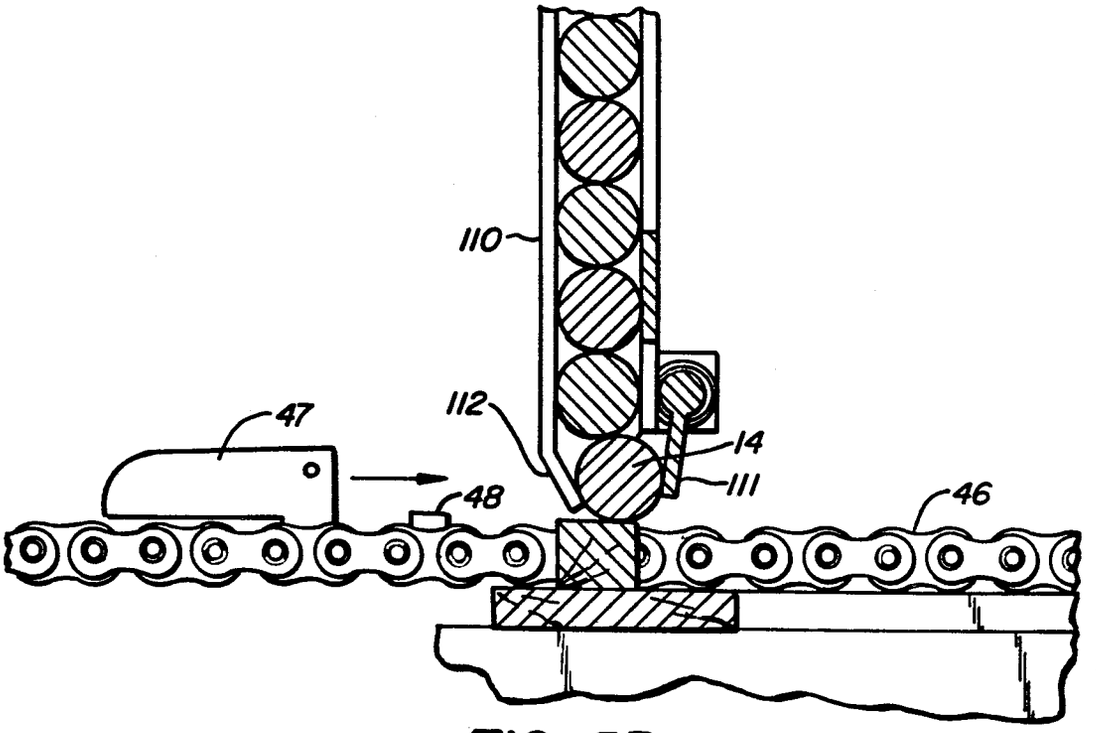

FIG. 5B.

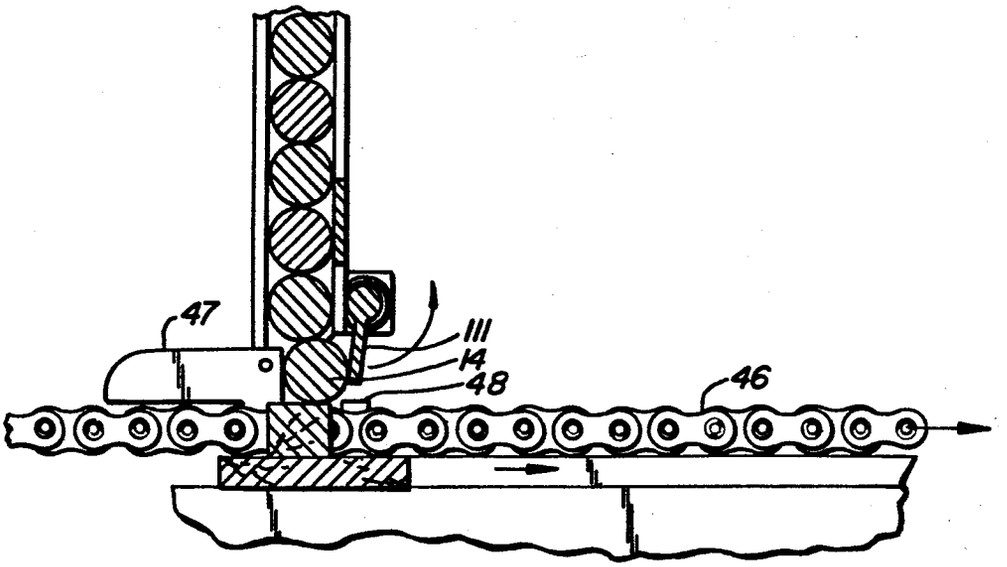

FIG. 5C.

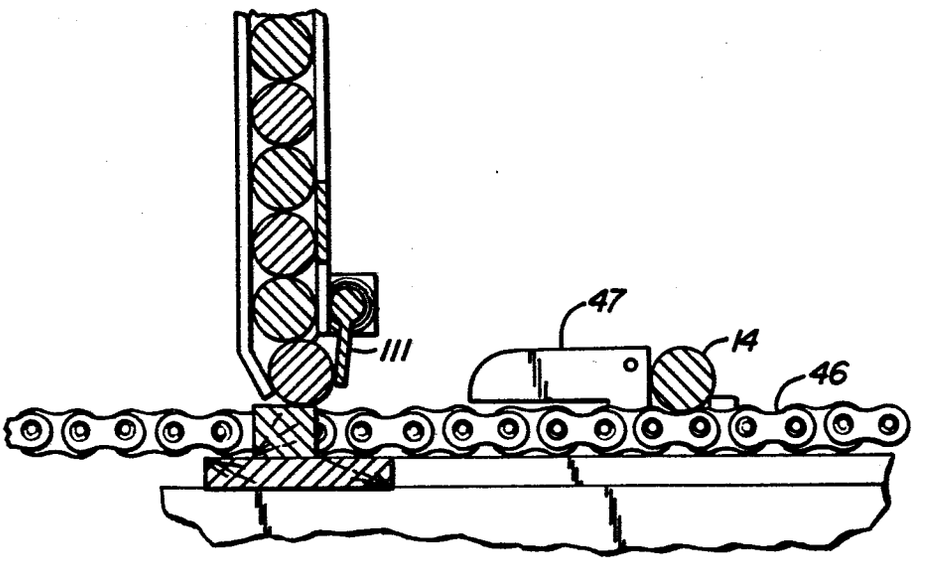

FIG. 5D.

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 83 30 0675

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Y	DE-U-7 405 028 (J. VÖGELE AG) * Pages 4-8; figures 1-4 *	1,2,5 8,10, 12	E 01 C 23/04
Y	US-A-3 068 766 (R.L. HOUCK) * Column 1, line 53 - column 3, line 28; figures 1-4 *	1,2,5 8,10, 12	
A	DE-U-7 432 889 (H. MILKE KG) * Pages 7-10; figures 2, 3 *	1,2,5 8,12	
A	US-A-2 596 206 (F.D. CARNES) * Column 2, line 31 - column 4, line 13; figures 1-6 *	1,2,5 8,12	
A	BE-A- 573 007 (KEYSER) * Page 2, line 20 - page 4, line 5; figures 1-10 *	1,2,5 8,12	TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
A	EP-A-0 051 885 (MOSER)		E 01 C 23/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	07-09-1983	PAETZEL H-J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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