Oct. 17, 1967 R. B. HOLIFIELD 3,347,597

JET CLEANING APPARATUS AND GROOVE ROUTER FOR CONCRETE PAVEMENTS

Filed Oct. 23, 1965 3 Sheets-Sheet 1

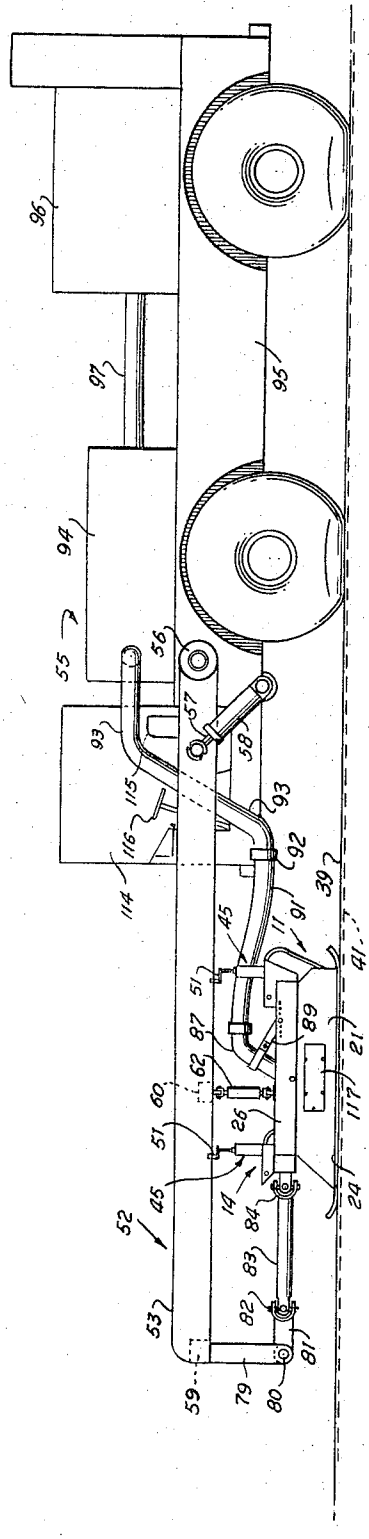


Fig. 1

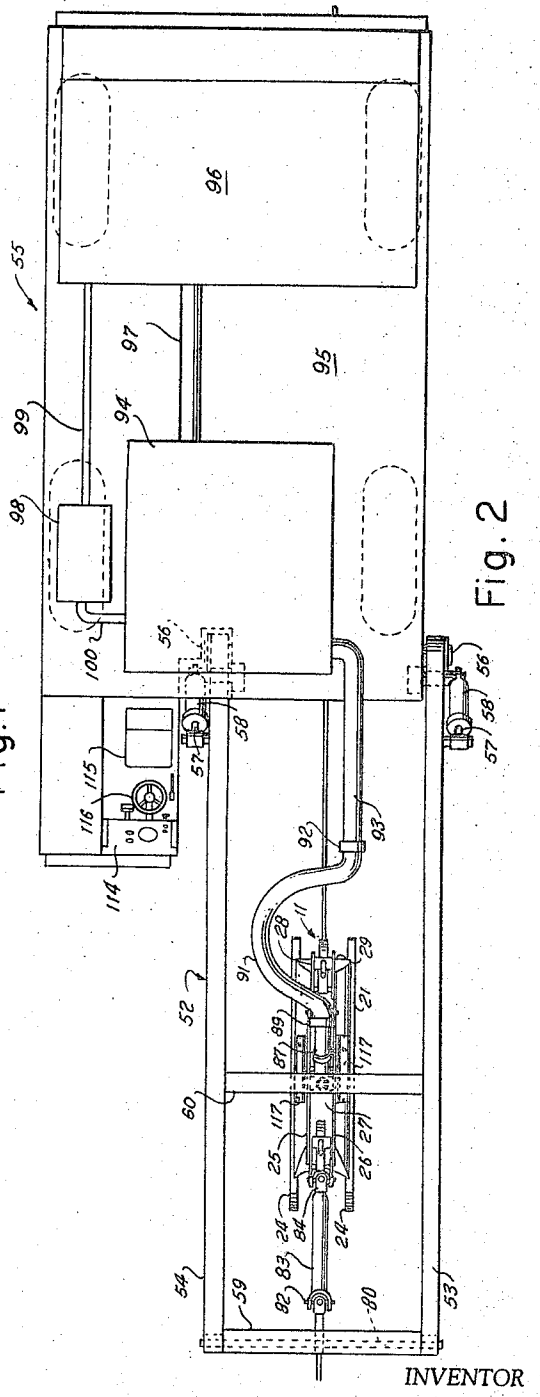


Fig. 2

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3 Sheets-Sheet 2

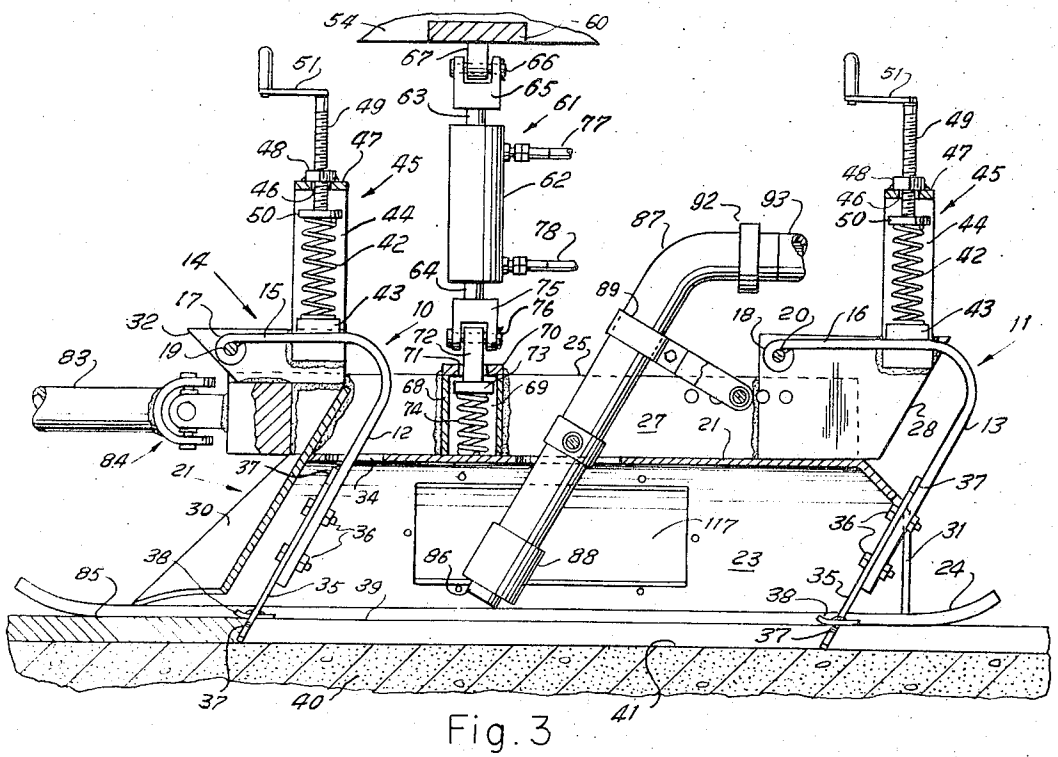


Fig. 3

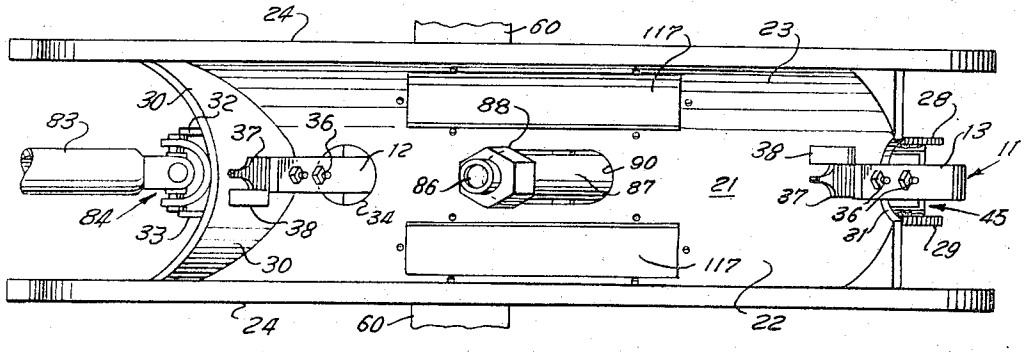


Fig. 4

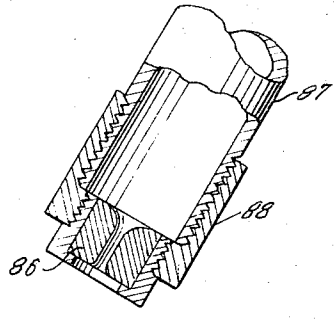


Fig. 5

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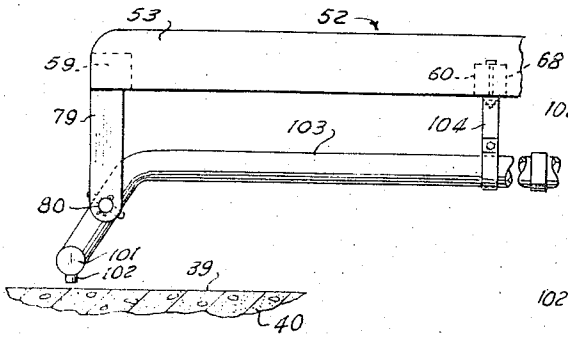


Fig. 6

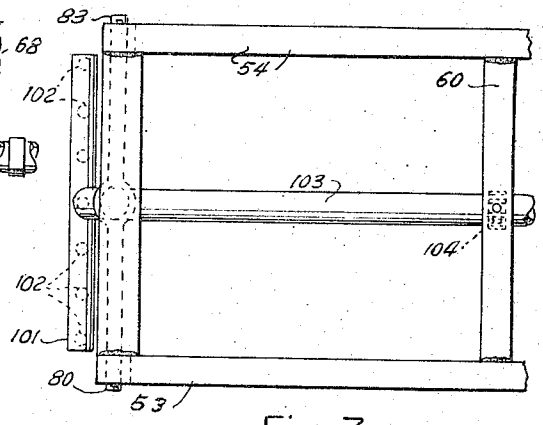


Fig. 7

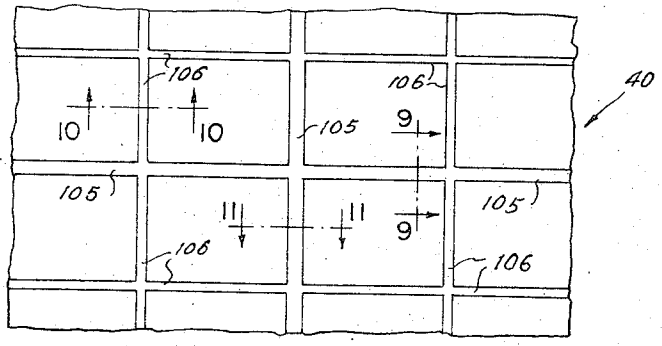


Fig. 8

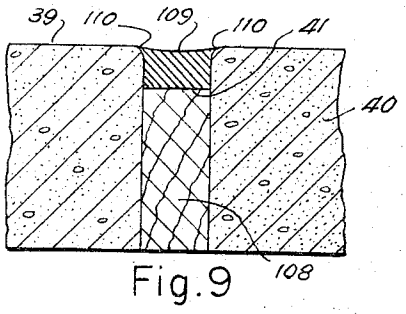


Fig. 9

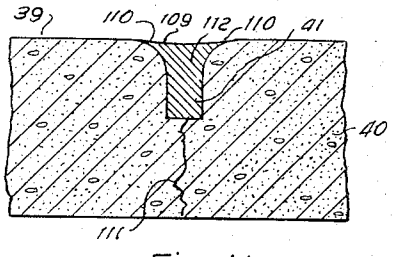


Fig. 11

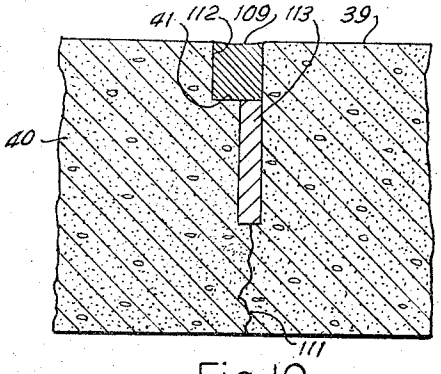


Fig. 10

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JET CLEANING APPARATUS AND GROOVE ROUTER FOR CONCRETE PAVEMENTS

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Filed Oct. 23, 1965, Ser. No. 503,127
6 Claims. (Cl. 299—36)

This invention relates to apparatus and method for cleaning and routing out the joints in concrete pavements to remove sealants, and the accumulation of undesirable foreign materials, preparatory to the replacement of fillers and sealants along the joints.

Concrete pavements, such as aircraft landing and taxiing strips, hangar floors, parking areas and roadways are commonly comprised of sections whose abutments are filled with sealants, generally composed of asphaltic materials, serving to prevent the destructive effects of water, and other deleterious materials, from entering the joints and undermining the pavement. Such fillers and sealants, being of an elastic character provide for expansion and contraction, or linear movement of the concrete sections when affected by temperature changes, load stresses, and other factors.

It is of particular importance to maintain the alignment of the sections of concrete along aircraft runways and adjacent taxiing areas, and when necessary, remove all dust, grit, and other materials from the joints between the concrete sections, as well as all surface areas, which may be sucked into aircraft engines resulting in malfunctions and thus presenting hazards which should be meticulously avoided.

The elastic-like sealant materials used in filling the joints between the concrete sections will, in due time, deterioriate and become impregnated with sand, grit, and other undesirable materials, and must be periodically replaced. Due to expansion, contraction, settling of the earth beneath the pavements, load stresses, and other factors, fractures will occur in the concrete sections which must be thoroughly cleaned and sealed and in order to insure a positive and permanent seal, the cracks or fractures should be routed out to a suitable depth and uniform width to receive the sealant material.

A variety of apparatus and mechanisms have been devised for routing or plowing out the joints between concrete pavement sections, and cleaning these joints by removing any loose substances therefrom but many such devices fail to perform their function in a completely satisfactory manner. The invention is designed to provide a mechanism embodying features by which the operations here under consideration can be effectively accomplished.

A prime object of the invention, therefore, is that of providing a simple and economical device by which the so-called expansion joints, as well as cracks and fractures in concrete pavements, can be routed out to remove deteriorated and impotent sealants and filler materials, with any accumulated foreign matter, and at once remove the dirt and grit and loose aggregate from the joints and fractures whereby repairs can be accomplished and the pavement maintained in its proper condition by refilling the cleaned joints and fractures with a fresh sealant.

Another object of the invention is that of providing a mechanism which may be readily attached to a conventional vehicle, or operatively connected to a unit of special design, as desired, and propelled thereby along the affected joints and fractures.

Due the varying character of the materials to be removed from the originally defined joints, which depends largely upon the type of filler initially employed and which it is desirable to replace, an object of the invention is that of providing controlled pressure means for the air

jet stream utilized in dislodging the loosened materials from the joints in the wake of the plow or routing element, such jet action requiring from 500 to 4,000 p.s.i. for best performance, and necessitating a reasonably close tolerance in pressure controls to avoid widening the joint or groove beyond a specified dimension.

Broadly, the invention contemplates the provision of apparatus for cleaning the joints and fractures in concrete pavements in which is embodied mechanical features by which the affected joints and fractures can be thoroughly divested of all materials therein, of whatever character, and maintained at uniform widths and depths, and to provide a method by which the joints and fractures can be adequately prepared to receive a fresh application of a sealant at a minimum of cost and substantial saving in time and labor.

While the foregoing objects are paramount, other and lesser objects will become apparent as the description proceeds when considered in connection with the appended drawings wherein:

FIGURE 1 is a side elevational view of the invention attached forwardly of a typical propelling vehicle, showing the device in operative position as it is moved along a joint.

FIGURE 2 is a plan view of the mechanism illustrating the carriage, the plows and jet assemblies, the pump and fluid conduit, and hydraulic depth control.

FIGURE 3 is an enlarged longitudinal sectional view of the invention in operative arrangement, showing the spring tensioned plows, the tensioning adjustment mechanisms, the shoes and jet element.

FIGURE 4 is a bottom view of the invention showing the relative positions of the plows and the jet element.

FIGURE 5 is a fragmentary sectional view of the jet nozzle.

FIGURE 6 is a fragmentary side view of the front end of the carriage supporting a surface cleaning attachment embodying an air conduit and manifold having a plurality of jets thereon.

FIGURE 7 is a plan view of the structure shown in FIGURE 6, the jets being shown in dotted lines.

FIGURE 8 is a fragmentary plan view of a typical concrete pavement showing, in grid fashion, a series of expansion joints and repaired fractures traversing the surface.

FIGURE 9 is a fragmentary sectional view, on line 9—9 of FIGURE 8, showing a typical sectional joint having a sealant therein.

FIGURE 10 is another fragmentary sectional view, on line 10—10 of FIGURE 9, showing one type of fracture or crack in the concrete slab having been cleaned and repaired, and

FIGURE 11 is another sectional view, on line 11—11 of FIGURE 9, showing still another type of fracture having been cleaned and shaped, and filled with a sealant.

The mechanism comprising the apparatus consists of a pair of plows **10** and **11** having shank portions **12** and **13** which extend downwardly and incline forwardly of their supporting carriage, generally designated by the numeral **14**, and have beam portions **15** and **16** which are normally in a horizontal plane and whose forward ends are rolled to form integral sleeves **17** and **18** through which pins **19** and **20** are arranged to provide a limited hinging action for the plows **10** and **11**, as shown in FIGURE 3.

The carriage **14**, shown in detail in FIGURES 3 and 4, includes a housing **21** which is arcuate in transverse section, having downwardly and outwardly curved sides **22** and **23**, and secured along the lower edge of each of the sides **22** and **23** is a runner or shoe **24**. The housing **21** has a pair of parallel plates **25** and **26** welded longi-

tudinally thereof, and laterally spaced, along its crown defining an open channel **27**. Welded to each of the plates **25** and **26** at their rearmost ends, are angular plates **28** and **29** which extend rearwardly beyond the rearmost ends of the plates **25** and **26**, as shown particularly in FIGURE 3.

The plows **10** and **11** are in tandem alignment and arranged at opposite ends of the housing **21**, and the rearmost plow **11** is supported between the forward ends of the plates **28** and **29** on its pin **20**. While the forward end of the housing **21** has a concavo-convex closure **30**, shown in FIGURES 3 and 4, the rear end has an opening **31** in its lower portion through which the shank portion **13** of the rearmost plow **11** extends, projecting downwardly at an obtuse angle into the housing **21**, as best shown in FIGURES 3 and 4.

Welded to the forward ends of the plates **25** and **26** are angular plates **32** and **33** which extend beyond the forward ends of the plates **25** and **26** and through which the pin **19** is arranged, the latter providing a support for the forward plow **10**, the pin **19** being arranged through the sleeve **17** formed by rolling the end of the beam portion **15** of the plow **10**. The shank portion **12** of the plow **10** extends downwardly at an obtuse angle through an opening **34** in the top of the housing **21** near the front closure **30** thereof, as shown in FIGURES 3 and 4.

A router blade **35** is attached by bolts **36** to the lower end of each of the shanks **12** and **13** of the plows **10** and **11**, and each may be reversible having a point **37** on each end. Each blade **35** has a shoe **38** integrally secured, as by welding, to one of its edges adjacent to the point **37** whose plane is angular with respect to that of the plow shank, and engages the surface **39** of the pavement **40** on one side of the groove **41** and functions as a depth gauge for the points **37** so as to insure a uniform depth, as indicated by reference to FIGURES 1 and 3, and to enable the plow to pass across the open transverse grooved joints.

Each of the plows **10** and **11** is biased against the work by a compression spring **42** whose lower end engages the top surface of each beam **15** and **16** of the plows **10** and **11**, extending through a stationary guide ring **43**, each of whose sides is welded or otherwise secured to the laterally spaced and vertical leg members **44** of an inverted elongated U-shaped element **45**, the lowermost ends of the members **44** being welded to the inner upper surfaces of the plates **28**, **29**, **32** and **33**, as shown in FIGURES 3 and 4, and embrace the beams **15** and **16** of the plows **10** and **11**.

Each of the elements **45** has an aperture **46** in the horizontal portion **47**, which connects the leg members **44**, and an internally threaded nut **48** is welded thereon to register with the aperture **46**. A threaded shaft **49** is arranged through the nut **48** and has a disc **50** attached to its lowermost end bearing upon the upper end of the compression spring **42**. A crank **51** is attached to the upper end of the shaft **49** by which it can be rotated and threaded upwardly or downwardly to control the yieldable pressure applied to the plows **10** and **11** according to the particular requirements.

The carriage **14** is connected to a frame **52** comprising a pair of parallel beams **53** and **54** which are spaced apart, as shown in FIGURE 2, and have their inner ends pivotally connected to the propelling vehicle **55**. The frame **52** can be raised and lowered on its pivots **56** by hydraulic plungers **57** pivotally attached to the beams **53** and **54** and operating in cylinders **58** whose ends are pivotally connected to the forward end of the vehicle **55**, as best shown in FIGURES 1 and 2.

The beams **53** and **54** of the frame **52** are connected by transverse members **59** and **60**, the former being arranged between the foremost ends of the beams **53** and **54**, while the member **60** is spaced rearwardly from the member **59** above the carriage **14** which is connected to

the member **60** by a vertically arranged hydraulic ram assembly **61** which comprises a cylinder **62** and a pair of opposingly actuated plungers **63** and **64**. The upper plunger **63** has a clevis **65** on its outer end which is hingedly secured by a pin **66** to a lug **67** integrally secured to the underside of the transverse member **60**.

Arranged transversely of the channel **27**, between the parallel plates **25** and **26** defining the same, are plates **68** which form a rectangular housing **69** rearwardly of the forward plow **10**. Each of the transverse plates **68** has an elongated block **70** welded along its upper edge and extending inwardly to form a relatively narrow slot **71** therebetween through which is arranged a block **72** having a plate **73** secured to its lower end bearing against the upper end of a compression spring **74** seated in the housing **69**.

The upper end of the block **72** is apertured and is hingedly connected to a clevis **75** on the lower end of the plunger **64** by a pin **76**. The cylinder **62** has hydraulic fluid lines **77** and **78** connected into its opposite ends whereby controlled pressured can be imposed upon the carriage **14**, the spring **74** providing for a degree of yieldability as the device is moved along the pavement **40**.

Depending from the forward ends of the beams **52** and **53**, and rigidly connected thereto, are hitch elements **79** having a shaft **80** pivoted at each end to their lowermost ends. A link **81** is rigidly attached to the shaft **80**, intermediate its ends, and is pivotally coupled, through a universal joint **82**, to a tubular draft link **83** whose inner end is connected through a universal joint **84** to the front end of the carriage **14**, as shown in FIGURES 1, 2, 3 and 4.

It is apparent that, by reason of the flexible connections between the carriage **14** and the supporting frame **52**, the plows **10** and **11** can be easily guided along the joints and fractures in the pavement **40** while controlling the downward pressures required through the medium of the hydraulic units **58** and **62**. In porting the carriage **14**, while inoperative, the frame **52** can be raised by the hydraulic rams **58**.

As the deteriorated filler or sealant **85** is removed from the joint grooves **41** by the plows **10** and **11**, the loose aggregate, including concrete particles, dirt, grit, and other undesirables, are removed from the groove **41** by compressed air, or a combination of air and a suitable liquid, such as water, or water containing a suitable solvent, is directed into the groove **41** through a jet **86** connected to the lower end of a nozzle **87** by a fitting **88**, as shown in FIGURES 3 and 4, and in detail in FIGURE 5.

The nozzle **87** is secured to the carriage **14** by a clamp **89** and extends downwardly at an obtuse angle through an opening **90** in the top of the housing **21** of the carriage **14**, and approximately intermediate the ends thereof, as shown in FIGURES 3 and 4. The opposite end of the nozzle **87** is connected through a flexible tube **91** by a coupling **92** to a conduit **93** connected to a pump **94** on the forward portion of the vehicle **55** which draws water or solutions from the reservoir **95** in the bottom of the vehicle **55**. The pump **94** is driven by the vehicle motor **96** mounted on the rear thereof through a shaft **97**, as shown in FIGURES 1 and 2. An air compressor **98** is mounted on the vehicle **55** adjacent to the pump **94**, which is also driven by the motor **96**, through a shaft **99** and has a connection **100** with the water pump **94**.

In FIGURES 6 and 7 is illustrated a sweeper attachment comprising an air or water manifold **101** having a series of jets **102** in its underside. The manifold **101** is tubular and has a rigid connection intermediate its ends with a conduit **103** which may be connected to the reservoir **95** through the pump **94** or directly to the air compressor **98**. The manifold **101** is transverse to the direction of travel of the vehicle **55** and is supported on the forward end of the frame **52** by the member **79** and the shaft **80** in the place of the assembly shown in FIGURES

1 and 2. The conduit **103** is suspended by a clamp **104** from the transverse element **60** between the frame beams **53** and **54**, as shown in FIGURES 6 and 7.

By this arrangement the surface **39** of the pavement **40**, as well as the grooves **41**, can be cleaned of all loose dirt and grit, and other undesirable matter, either by a compressed air blast or by a water bath.

In FIGURE 8 is fragmentarily shown a typical grid pattern of a pavement such as may be used as an aircraft runway or taxiing strip, the joints **105** and **106** between the sections **107** being of different widths, as desired, and arranged both longitudinally and transversely of the pavement **40**. The wider joints **105** and **106** conventionally occur between sections of the pavement **40** when originally laid and expansion strips **108**, comprised of wood, or other suitable material, separates the sections below the surface **39** thereof, as shown in FIGURE 9.

A water proof sealant, usually an asphaltic material **109**, is used to fill the groove **41** above the expansion strip **108** to the level of the surface **39**. The sealant material **109**, after periods of time, depending upon such factors as climate, load stresses, and the like, will deteriorate and must be removed and replaced. The removal of the spent sealant **85** can be accomplished by the plows **10** and **11**, as shown in FIGURE 3, and as previously described, and the radii **110** along each side of the joint are formed to insure an even surface over which the traffic can move with a minimum of vibratory action.

Fractures or cracks **111** often occur in pavements, and may follow any course, such as the typical fractures shown in FIGURES 10 and 11. These may be plowed out, or grooved to a predetermined depth by the plows **10** and **11**, and the radii **110** formed along the edges of the resulting grooves **112** and a sealant **109** injected thereinto to prevent further damage and repair the surface **39**. In some instances the fracture **111** is plowed out to a depth below that of the normal groove, and somewhat narrower, whereby an expansion strip **113** can be inserted, as indicated in FIGURE 10, and a filler or sealant **109** injected into the groove **41** thereabove.

In operation, as the mechanism is moved along a joint **105** or **106** the plows **10** and **11** are lowered thereinto by the operation of the hydraulic ram **58** to lower the frame **52** supporting the carriage **14**. Pressure can be applied to the carriage **14** to hold it firmly against the surface **39** of the pavement **40** through the hydraulic cylinder **62** and its plungers **63** and **64**. Tension is applied to each of the plows **10** and **11**, as desired, through the cranks **51** and their springs **42**.

As the carriage **14** is moved along the surface **39** on its runners or shoes **24** yieldability to the uneven surfaces is provided through the compression spring **74**, and complete flexibility is provided through the couplings on each end of the cylinder **62** and the universal joints **82** and **84** in the linkage **81** and **83** by which the carriage **14** is connected to its supporting frame **52**.

A compartment **114** is provided on the vehicle **55** for the operator, including a seat **115** and a steering device **116**. Access to the plows **10** and **11**, and the nozzle **86** may be had through openings on each side of the housing **21** which are closed by removable plates **117**.

While the invention has been illustrated and described in its preferred embodiment, certain structural changes and arrangement of parts may be resorted to by persons skilled in the art without departing from the spirit and intent thereof or the scope of the appended claims.

What is claimed is:

1. In apparatus for cleaning and routing out expansion joints and cracks in concrete pavements, such as airport runways, to remove old and decomposed fillers and sealants and accumulated foreign materials from said expansion joints and to enlarge and shape said cracks, preparatory to replacing said fillers and sealants and filling said cracks, the combination of an automotive vehicle having a frame, an elongated boom having one of its ends pivotally connected to the frame of said vehicle, forwardly thereof, and normally extending substantially horizontally, forwardly of said vehicle, hydraulically operable means acting on said frame and said boom whereby the inclination of said boom may be adjusted within predetermined limits, an elongated skid below said boom having a pair of supporting runners engageable with a concrete pavement on opposite sides of an expansion joint or crack therein, draft means whereby said skid is connected to said boom, suspension means whereby said skid is connected to said boom rearwardly of said draft connection, a pair of plows on said skid in tandem relation to each other, engageable with an expansion joint or crack in a concrete pavement, a downwardly extending nozzle on said skid, between said plows, arranged to direct a stream of fluid at high velocity against an expansion joint or crack in a concrete pavement in the path of said plows, means on said vehicle for supplying fluid to said nozzle at predetermined superatmospheric pressure and means on said skid enclosing said plows and said nozzle and confining fluid as discharged from said nozzle and such material as may be displaced from an expansion joint or crack in a concrete pavement against which such fluid may be directed.

2. The structure of claim **1**, said suspension means including a hydraulic ram having a pair of relatively movable members adjustable longitudinally and rotatively relative to each other, one of said members being pivotally connected to the under side of said boom whereby it is adjustable rotatively relative thereto about a horizontal axis extending substantially parallel to said boom, a spring housing on said skid having a compression spring therein, a plunger having one of its ends received in said spring housing, in opposing relation to said spring, and secured against rotation relative to said housing, and having the end thereof opposite said one of its ends pivotally connected to the other of said members whereby it is adjustable rotatively relative thereto about a horizontal axis extending substantially parallel to said skid, the arrangement being such that said skid is pivotally and flexibly connected to said boom, in spaced apart relation thereto, and may be freely suspended therefrom, while at the same time any desired superatmospheric pressure may be yieldably applied to said skid, to increase the effective weight thereof, by operation of said hydraulic ram.

3. The structure of claim **1**, said plows each having a downwardly and forwardly inclined shank portion having a router blade removably connected to its lower end, and having a forwardly extending beam portion continuous with the upper end of said shank portion, said beam portion being pivotally connected, forwardly thereof, to said skid for rotative adjustment about a horizontal axis, and adjustable means including a compression spring acting on said beam portion to urge it downwardly about its pivot.

4. The structure of claim **1**, said draft means including a rigid downward extension of said boom, forwardly thereof, a draw bar having one of its ends pivotally connected to the lowermost extremity of said downward extension for rotative adjustment about a horizontal axis extending transversely of said boom, and linkage including a pair of universal joints connecting said draw bar to said skid.

5. The structure of claim **1**, and sweeper means, interchangeable with said skid, including a fluid conduit having means whereby it is removably suspended from said boom and extending longitudinally of said boom and below it, said conduit being in fluid communication with said means on said vehicle for supplying fluid to said first mentioned nozzle at predetermined superatmospheric pressure, and a manifold communicating with said conduit, forwardly thereof, and extending transversely of said boom, forwardly thereof, in close proximity to the ground in one of its operative positions, said manifold having a plurality of longitudinally spaced, downwardly facing nozzles communicating with its under side.

6. The combination of an automotive vehicle having a frame, an elongated boom having one of its ends pivotally connected to said frame, forwardly thereof, and normally extending substantially horizontally, forwardly of said vehicle, hydraulically operable means acting on said frame and said boom whereby the inclination of said boom may be adjusted within predetermined limits, an elongated skid below said boom having a pair of supporting runners on opposite sides thereof, draft means whereby said skid is connected to said boom, forwardly thereof, suspension means whereby said skid is connected to said boom rearwardly of said draft connection, and a plow on said skid, said plow having a downwardly and forwardly inclined shank portion having a router blade removably connected to its lower end, and having a forwardly extending beam portion continuous with the upper end of said shank portion, said beam portion being pivotally connected, forwardly thereof, to said skid for rotative adjustment about a horizontal axis, and adjustable spring means acting on said beam portion to urge said plow downwardly about said pivotal connection between said beam portion and said skid.

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