May 27, 1941. C. A. CAMPBELL 2,243,243

SANDER

Filed Jan. 16, 1940 3 Sheets-Sheet 1

Fig. 1

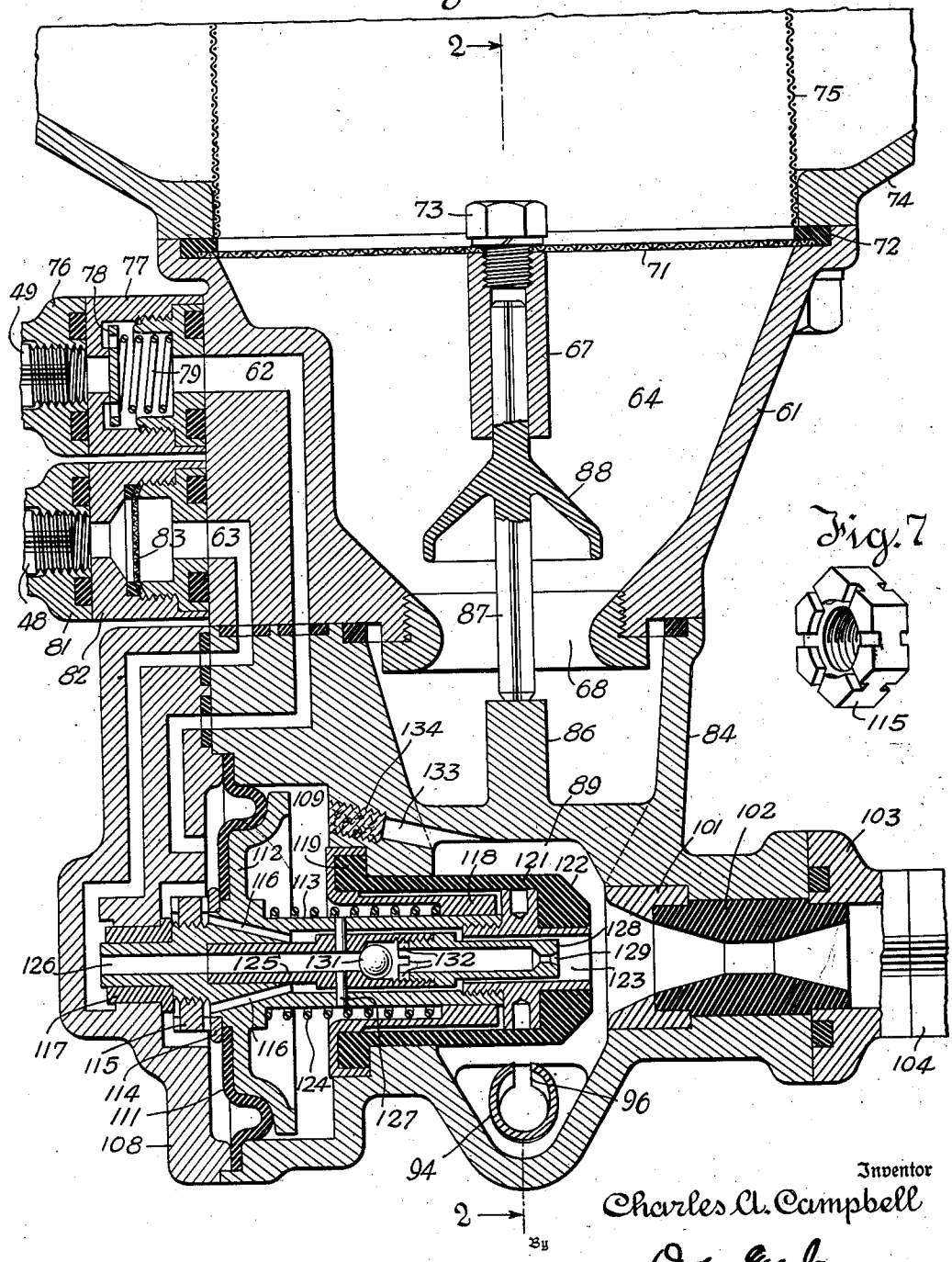

Fig. 7

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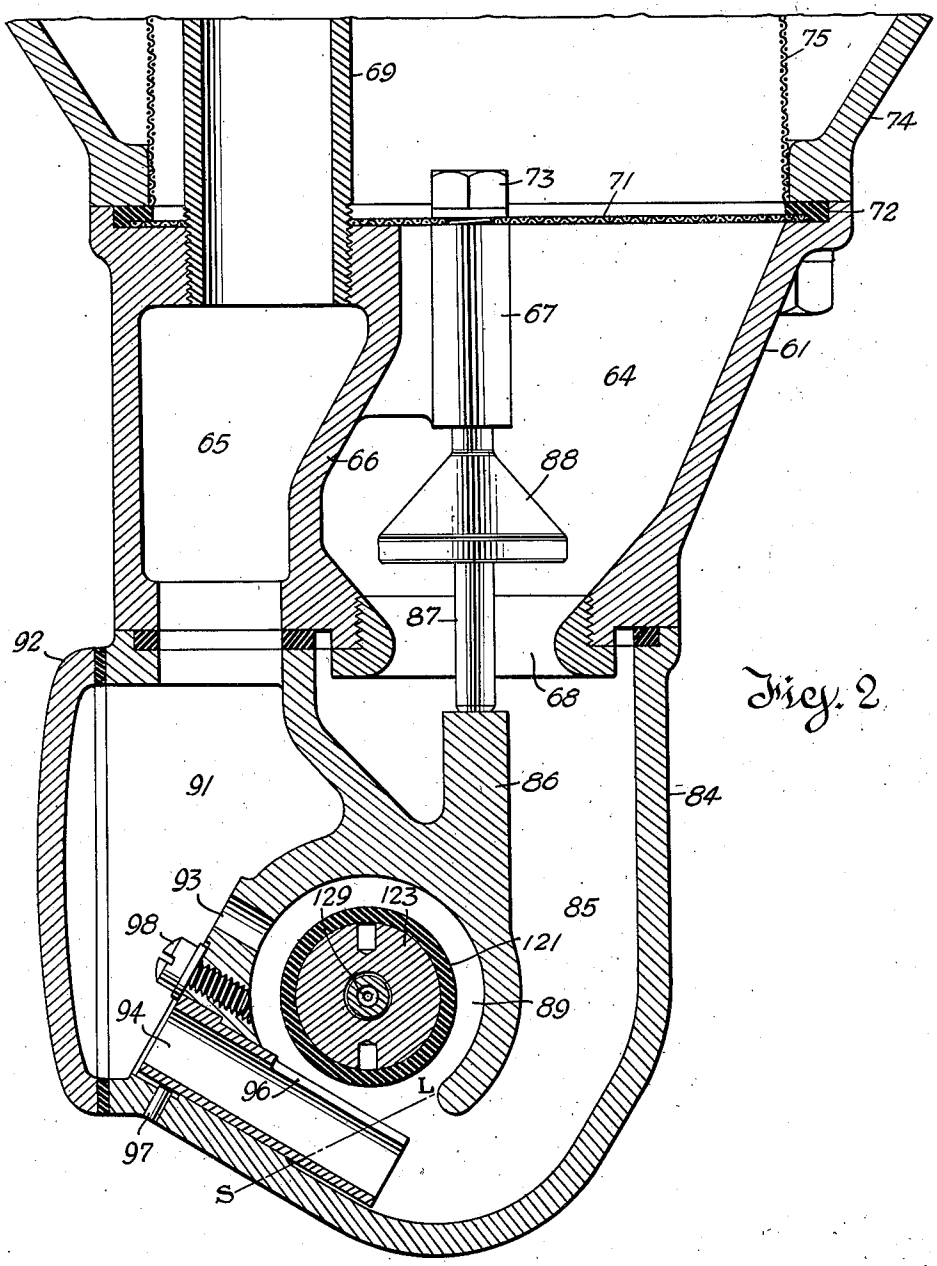

Fig. 2

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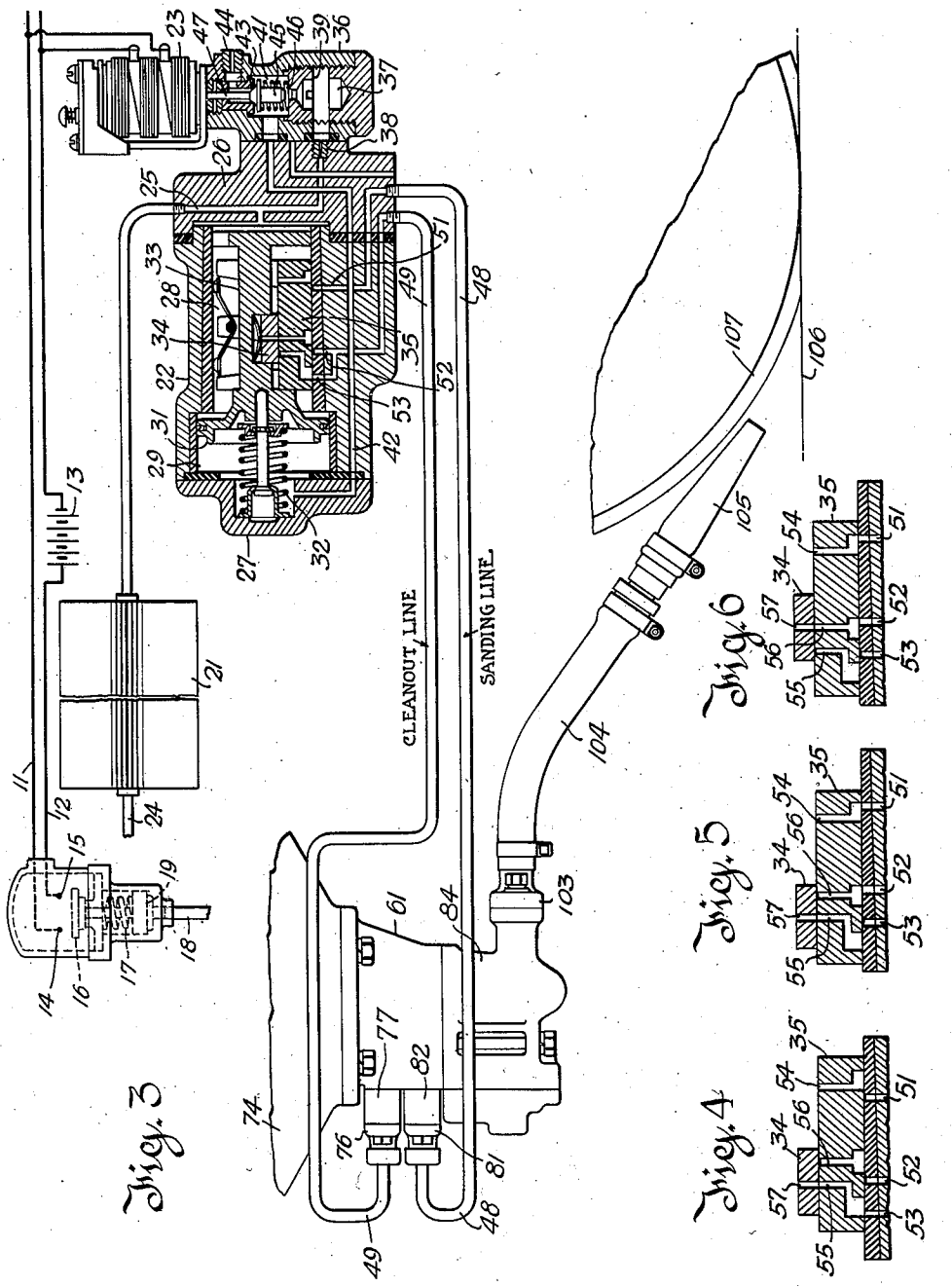

Fig. 3

Fig. 6

Fig. 5

Fig. 4

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Patented May 27, 1941

2,243,243

UNITED STATES PATENT OFFICE

2,243,243

SANDER

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Application January 16, 1940, Serial No. 314,173

31 Claims. (Cl. 291—11)

This invention relates to sand traps for railway vehicles, and particularly to such devices for use in high speed trains.

This application is in part a continuation of my application Serial No. 274,295, filed May 17, 1939.

On such trains the required short stopping distance can be attained only by very rapid application of the brakes with very high braking ratios. The approach to wheel sliding even with good rail conditions often is so close that sanding throughout the train during all brake applications, or at least during all heavy or emergency applications, is a desirable safeguard.

In such case, rapid response of the sanders is necessary because sanding must commence at least as soon as the brake application becomes effective. Sanding must be certain, so the trap should permit clean-out functions which will unfailing blow ice and mud from the related sanding nozzle. Economy in the use of sand is important because frequent operation of the sanders must be provided for, and sand storage capacity is limited.

These requirements conflict in a considerable degree and the present invention involves the reconciliation of operating factors to ensure rapid, certain and economical functioning under all conditions.

The sand trap is gravity fed and retains the sand except when an air operated ejector feeds sand therefrom to the sand pipe. A pneumatically actuated intercepting valve is interposed between the trap and the sand pipe and is momentarily closed to permit the sand pipe to be subjected to a clean-out pressure blast preliminarily to actual sanding.

The intercepting valve and its actuating mechanism are novel and have improved operating characteristics; a wholly new stirring jet operated by air entering the sand trap at atmospheric pressure is used; and compensating means are, for the first time, associated with the stirring jet, and serve to equalize the feeding flow of sand to the ejector and hence to the sand pipe.

The sand trap may be used with any controlling mechanism which will properly deliver clean-out air and sanding air under pressure, but the relay valve shown has decided advantages and many novel characteristics.

In the drawings:

Figure 1 is a vertical axial section through a sand trap embodying the invention.

Figure 2 is a vertical section on the line 2—2 of Figure 1.

Figure 3 is a view showing the control connections in diagram and in elevation, and showing the relay valve in axial section, the valve being in running (i. e. non-sanding) position.

Figure 4 is a view of the slide valve and graduating valve illustrated in Figure 3 but showing the clean-out position assumed as the relay moves to sanding position.

Figure 5 is a similar view of a sanding position.

Figure 6 is a similar view showing the final clean-out position assumed as the valve moves from sanding back to running or inactive position.

Figure 7 is a detail view of a ported nut used in the device.

Refer to Figures 3 to 6. The circuit made up of the wires 11 and 12 extends throughout the train, being connected from car to car by the usual jumpers or releasable connectors. A source of current conventionally represented as battery 13 is included in the circuit. This is controlled by a normally open switch comprising the contacts 14 and 15 to which the wires 11 and 12 are connected and a bridging contactor 16 which is normally held in circuit-breaking position by the coil compression spring 17, and may be forced to circuit closing position by the admission of air under pressure through the pipe 18 to the space below the actuating piston 19.

A sanding valve of any suitable type may be used to maintain the pipe 18 normally vented and to admit compressed air through the pipe when sanding is desired. Such a valve may be capable of manual operation and may include means to operate it as an incident to brake application, particularly emergency brake applications.

A sanding valve suited to this function forms the subject matter of the patent to Campbell No. 2,035,533 issued March 31, 1936.

Mounted on each car, or at any rate, on each vehicle on which sanding is to occur, is a local source of air under pressure diagrammatically indicated by the reservoir 21, a sanding relay valve generally indicated by the numeral 22 applied to its housing and a magnet or solenoid winding 23 for controlling the relay valve, the winding 23 being connected between the wires 11 and 12 as clearly indicated in Figure 3.

The reservoir 21 is charged by any suitable means through a connection 24. The charging means is not illustrated but means well-known in the art are local compressors, reservoir lines extending throughout the train from the main reservoir at the head of the train and restricted

charging connections from supply reservoirs forming part of conventional air brake systems.

The reservoir 21 is piped as shown to a port 25 in a so-called pipe bracket 26. This is merely a supporting means for the pneumatic apparatus and is rigidly mounted on the vehicle. It affords connections for all pipes in the sander system. Thus, components of the relay valve may be dismounted without breaking pipe connections.

The housing 22 of the relay valve is mounted against one side of the bracket 26 and its outer end is closed by removable cap 27. The housing 22 encloses a bushed slide valve chamber 28 and a bushed cylinder 29 in which a piston 31 is slidable. The piston 31 is biased to its inward or running position (shown in Figure 3) by a coil compression spring 32. Rigidly attached to the piston is a stem 33 notched to confine a graduating valve 34, which controls ports hereinafter described, in a main slide valve 35 which works on a seat in the valve chamber bushing and controls certain ports formed therein.

The valve 35 has limited lost motion with reference to the piston stem 33. The space to the right of the piston 31 and consequently the slide valve chamber 28, is subject constantly to pressure in the reservoir 21 since a branch of the port 25, clearly shown in the drawings, leads to this chamber.

To effect the sanding operation, the piston 31 is caused to move gradually to its left-hand position and remain there during the sanding operation. At termination of the sanding operation, the piston 31 moves gradually back to the normal position shown in Figure 3 and carries out certain valve sequences to be described.

Mounted on the opposite side of the bracket 26 from the housing 22 is a valve housing 36. This housing has a supply chamber 37 fed at a limited rate by the port 25 through a restricted choke 38. Above the chamber 36 and separated therefrom by ported valve seat element 39 is a chamber 41 in free communication by way of port 42 with the space to the left of the piston 31. At the upper end of the chamber 41 is a second valve seat element 43 which leads to a restricted discharge fitting 44. Coacting with the valve seat member 39 and the valve seat member 43 is double-beat poppet valve 45 which is urged to the exhaust seat by a coil compression spring 46. Thus, under normal conditions, air under pressure from reservoir 21 flows from chamber 37 through supply seat 39 to chamber 41 to port 42 and consequently to the space to the left of piston 31. This equalizes the pressures on opposite sides of the piston 31 so that the spring 32 shifts the relay valve piston to the normal or running position of Figure 3.

The valve 45 is arranged to be operated by the winding 23. There is a stem 47 which is connected to the armature (not shown) within the winding 23, so that when the winding is energized, the valve 45 is moved to close the supply port and open the exhaust port with the result that the space to the left of the piston 31 is vented to atmosphere at a rate controlled by the restricted exhaust fitting 44. Thus, when winding 23 is energized, the piston 31 moves gradually to the left. Ordinarily, the time required is adjusted to about one-second duration. When thereafter the winding 23 is de-energized, piston 31 returns to its running position (Figure 3) at a rate controlled by the size of the choke 38. This period of return may be slower, in which event a final clean-out blast will have a somewhat longer duration than the initial clean-out blast which precedes sanding.

Connected to the bracket 26 are a sanding pipe 48 and an impulse pipe 49. The sanding pipe 48 leads to a single sanding port 51 in the seat of the slide valve 35. The impulse pipe 49 leads to two impulse ports 52 and 53 also in the seat of the valve 35. The slide valve has three through ports, each of which has an extension on the lower face of the slide valve 35 in the direction of travel of that valve. These ports are: a sanding port 54 which coacts with the port 51 and which is constantly exposed to pressure in the chamber 28; an initial impulse port 55 and a final impulse port 56. The two impulse ports are controlled by the graduating valve 34 which either blanks the upper ends of the ports 55, 56 or connects the selected one of them with the slide valve chamber 28 by means of a through port 57.

The location of the ports is shown in the drawings and their functions can be described by referring to Figures 3 to 6.

Figure 3 shows "running position." The sanding port 54 is to the right of the sanding port 51 so that air is not supplied to the sanding pipe 48. Initial impulse port 55 registers with impulse port 53 but is blanked by the graduating valve 34. Port 57 in the graduating valve registers with the final impulse port 56 but that port is blanked at the seat of the slide-valve 35 so no air is supplied to the impulse pipe 49. Assume now that winding 23 is energized. Venting of the space to the left of the piston 31 causes the piston to move gradually to the left; slide valve 35 remains at rest, graduating valve 34 reaches the position shown in Figure 4 just as the stem 33 starts to move the slide valve 35. Port 57 in the graduating valve now exposes initial impulse port 55 so that air under pressure is supplied to the impulse pipe 49. This supply continues until the large lower end of port 55 passes beyond port 53. Before this occurs, port 54 will have opened into port 51, admitting air under pressure to sanding pipe 48.

Figure 5 shows the valve in the position when the piston 31 is at its outer limit of travel. When the winding 23 is deenergized, piston 31 starts to move to the right. The graduating valve 34 first shifts so that port 57 registers with final impulse port 56, as shown in Figure 6, while sanding port 54 is still in communication with sanding port 51. This occurs just as the stem 33 picks up main slide valve 35. The effect is to admit air through ports 57, 56, 52 to the impulse pipe 49 while air is being supplied to the sanding pipe 48. Continued motion of the piston 31 to the right shifts main slide valve 35 and the supply of air to both pipes is terminated at or about the same time, the parts resuming the position shown in Figure 3.

Thus, the sequence of flow is as follows: Admit air to the impulse pipe, then admit air to both pipes, then cut off flow of air to the impulse pipe while continuing to admit air to the sanding pipe. Flow to the sanding pipe then continues as long as sanding is desired. To terminate sanding the piston 31 is caused to move back to running position (Figure 3). The first effect is to admit air under pressure to the impulse pipe while admission to the sanding pipe continues, then the flow to both pipes is terminated.

The cycle may be modified somewhat. For example, it is not necessary to the operation of

the sand trap that flow to the sanding pipe continue after the final impulse flow is commenced. The operation described is typical of one to which the sand trap now about to be described is suited.

Referring to Figures 1, 2 and 3, the sand trap structure is supported as a unit by a bracket member 61 which is mounted either on the car body or on the truck by means not illustrated in the drawings. The details of support have nothing to do with the present invention and are subject to modification according to the particular scheme adopted, for a particular installation.

Member 61 has an impulse air passage 62, a sanding air passage 63 and a sand hopper 64 and a large atmospheric air passage 65 which is designed to furnish air to the stirring jet, as will be explained. The passage 65 is cored in a side boss 66 which projects into the sand hopper 64 at one side and which carries a hub 67 with vertical guideway formed therein. The particular form of the sand hopper 64 is not important and is sufficiently illustrated in the drawings. It is somewhat contracted at its lower end, the discharge passage at the lower end being defined by an inserted bushing 68 which is threaded in the member 61 and which preferably is made of wear-resisting material.

To supply air to the passage 65, an atmospheric intake pipe 69 is threaded into the upper end of the boss 66. It affords a large capacity flow passage and is open to atmosphere at its upper end where it is protected by any suitable means such as a screen and water deflecting baffle so that air may freely enter the pipe 69 but will not draw in any fluids which would affect the operation of the trap, particularly water.

Overlying the boss 66 and the hub 67 and encircling the pipe 69 is a horizontal screen 71 which is supported at its periphery on the seat for gasket 72 and which is held down at its center by a machine screw 73 threaded into the upper end of the hub 67.

The sand box proper is indicated at 74, but only the lower portion thereof is illustrated because it may assume various forms according to the particular class of service in which the sander is used. A vertical cylindrical sand screen 75 is shown as mounted in the sand box 74 and projecting upward from the plane of the gasket 72. The use of such screens is optional.

The clean-out line 49 is connected with the clean-out air passage 62 by way of a reinforced union fitting 76 of a form standard in the air brake art, and a check valve fitting 77. So far as is material to the invention, the fitting 77 contains a disc check valve 78 urged in a closing direction by a coil compression spring 79, the valve being arranged to open under flow from the passage 49 to the passage 62 and close against reverse flow.

The sanding pipe 48 connects with the sanding air passage 63 by way of another reinforced union fitting 81 and a strainer fitting 82. This is constructed of two separable parts threaded together and confining between them a screen 83. The purpose of this screen is to protect the rather small sanding air nozzle from scale or rust which might clog it.

It will be observed that the sand box 74 can be removed without dismounting the pipe connections and the same is true of the sand trap body 84 which is bolted against the bottom of the bracket member 61 and sealed thereto by gaskets, clearly shown in the drawings (Figs. 1 and 2). The connecting bolts between the parts 61 and 74 and 61 and 84 do not appear on the planes of section but their location is indicated in Figure 3. They are of conventional form.

The body 84 includes continuations of the passages 62 and 63 and these continuations are given the same reference numerals because they are in effect the same passages. There is also in the body 84 a sand passage 85 to which the sand hopper 64 delivers. In this passage there is an upstanding boss 86 upon which rests the lower end of a stem 87 whose upper end is slidably guided for vertical movement in the hub 67. The stem 87 carries an umbrella member 88 which, when the device is assembled, acts as a sand deflector because it is positioned above the bushing 68. Under these conditions, it controls the delivery of sand through the bushing 68, but if the body 84 be removed, descent of the umbrella 88 causes it to function as a valve, closing the passage through the bushing 68 and preventing the escape of sand in the event that the body 84 is removed for inspection or repair.

An important reason for using a separate bushing 68 is to facilitate insertion of the stem 87 and umbrella member 88.

Formed in the body 84 below and slightly to one side of the port through bushing 68 is a sand retaining chamber 89 which is generally cylindrical in form and around which the sand passage 85 curves so as to enter the sand retaining chamber from beneath. While the chamber 89 has been described as generally cylindrical, the chamber with the approach passage 85 forms a sort of snail shell housing.

On the opposite side of the chamber 89 from the approach passage 85 is an atmospheric air chamber 91. This is closed by removable cap 92 and communicates at its top freely with the atmospheric air chamber 65 and, hence, with the air inlet pipe 69. An auxiliary atmospheric port 93 connects the chamber 91 with the sand retaining chamber 89. This port has a regulatory function which determines its size, and, in certain cases, this port can be omitted. Its function is to by-pass the stirring jet about to be described, and by permitting a limited flow of air between chambers 89 and 91, it varies the compensating action of the stirring jet.

The stirring jet is in the form of a nozzle tube 94 which discharges below the normal sand level indicated in Figure 2 by the legend "SL". This level is not very precisely maintained. It represents the angle of repose of the entering sand after flowing downward through the hopper 64 and approach passage 85. Sand does not flow freely upward. In fact, the line SL represents the sand level commonly attained. This may be described as the lowest surface level encountered in service, it being understood that vibration, centrifugal effects rounding curves and buffing shocks, etc., would cause some shifting of the sand, and the occasional attainment of sand levels higher than the usual sand level.

The variations of sand levels lead to the provision on the upper face of the nozzle tube 94 of a so-called "compensating" slot 96. This slot is exposed for the greater part of its length when the sand does not rise above the line SL and is increasingly blinded by the sand when the level rises above the line SL as it occasionally does. The removable cap 92 is provided to give access to the nozzle and to the auxiliary port 93. The nozzle is inserted through a seat drilled in the

body 84. It is shouldered to limit its insertion and is slotted so that its alignment is determined by the pin 97. Nozzle tube 94 is held in place in any convenient way, a machine screw 98 being illustrated as used for that purpose.

It may be helpful to explain at this point that sand is fed to the chamber 89 by gravity flow but is discharged therefrom only by the operation of an air ejector. When the ejector operates, the pressure in the chamber 89 is reduced below atmospheric pressure because entering flow of the air through the approaching sand is practically cut off by the sand. As a result of this reduced pressure, atmospheric air flows by way of the pipe 69, passage 65 to chamber 91. From this, a part of it flows freely through the port 93 and the remainder flows through the stirring nozzle 94 which directs it against the approaching sand and performs two useful functions: it resists the unduly rapid approach of the sand and while holding the sand back stirs up a fog of sand particles which flow upward through the chamber to the ejector. This stirring action is modulated by the compensating slot 96. If the sand level is high, that is, above the line SL, more of the slot 96 is blinded and the stirring action is intensified. Since this stirring action resists the approach of sand, the effect is to equalize the sand flow and to assure that desirable operating condition in which a rather meager quantity of sand is entrained in a rapidly flowing current of air leading to the point of sanding.

The stirring nozzle is operated by air under atmospheric pressure, and this stirring nozzle, in conjunction with the compensator, has demonstrated great effectiveness in stabilizing the rate of sand delivery despite disturbing conditions such as vibration, shock, flow characteristics of the sand, and the like. The by-pass port 93 modifies the effective pressure differential which causes air to flow through the nozzle 94 and hence is in the nature of a convenient means for adjusting the action of the stirring nozzle. Once the proper size of port 93 for a given class of service has been determined, it need not be changed.

The discharge connection from the chamber 89 provides a horizontal passage concentric with the axis of the chamber 89 and above the level of sand (SL). The details of construction are best shown in Figure 1, and involve a wear-resisting insert 101 and a rubber bushing 102 which, together, produce a Venturi throat or contraction suited to the ejector function which is characteristic of the sand delivery mechanism.

The bolted flange 103 connects a flexible hose 104 which leads to a distensible rubber nozzle 105, not herein broadly claimed because it is the subject matter of other applications, but nevertheless performing a useful function in conjunction with the particular sand trap which is here disclosed. The nozzle 105 is directed to the angle between the rail, indicated diagrammatically at 106, and the wheel indicated diagrammatically at 107.

Projecting through chamber 89 and axially aligned with the throat produced by the members 101 and 102 is a nozzle structure which, during sanding is retracted so that when the nozzle directs a jet of air into the throat, air and suspended sand are drawn from the chamber 89 and discharged through the throat. During the clean-out operation, however, the nozzle moves toward the throat and an elastic member which serves also as a protecting sleeve seals on the member 101. Thus, sand is not withdrawn from the chamber 89 during the clean-out operation. On the contrary, air under pressure is delivered by the impulse pipe and later by the sander pipe or by both pipes together to develop pressure in the sanding hose 104. If the hose is clogged at the nozzle 105, dilation of the nozzle will clear the obstruction.

Air is delivered through the impulse pipe only for a short interval, at the commencement and again at the termination of the sanding operation. Hence, if the sand pipe is clear, no substantial pressure will be developed in the hose 104 but if the nozzle is obstructed the pressure will be very rapidly developed and even though the impulse pipe ceases to deliver air the sand pipe will operate to maintain the pressure developed until clearing occurs. At such time, the check valve 78 performs its intended function of preventing loss of pressure by back flow of air through the impulse pipe.

With this general statement of operation, the purpose of the construction now about to be explained can be followed.

Bolted to the body 84 is a cap 108 in which are formed extensions of the ports 62 and 63, these extensions bearing the same reference numerals. The cap 108 overlies a chamber 109 formed in the body 84 and clamps at its periphery a flexible diaphragm 111. This is of rubber-like material and has an annular corrugation to assure adequate motion. It is backed up by a suitably formed diaphragm plate 112 which is formed integrally with a tubular stem 113. The center of the diaphragm is clamped to the hub of the plate 112 by a ring or washer 114 and by a nut 115 threaded on the stem as shown. This nut is radially slotted on both faces, the slots leading to an annular groove which surrounds the threaded portion. The slots and the annular groove afford communication from the space to the left of the diaphragm 111 to drilled ports 116 which lead to the interior of the hollow stem 113. The ring 114 encircles and hence does not blind these ports. The purpose of slotting both faces of the nut is to assure that it can not be so mounted as to blind the ports 116. The construction of the nut 115 is clearly indicated in Figure 7.

The tubular stem 113 is guided at its outer or rear end in a bushing 117 pressed into an opening suitably located in the cap 108 and is guided at its inner or forward end in a sleeve-like bushing 118 which seats in a cavity formed in the inner face of the chamber 109 to receive it. The bushing 118, where it seats in the cavity just mentioned, is channeled and functions to confine a bead 119 on a thimble-like member 121. Member 121 is formed of rubber-like material and performs the dual function of protecting the guideway in bushing 118 from sand and of affording a conical valve surface 122 which coacts with the bushing 101 to seal the chamber 89 from the combining throat 102. The end portion which carries the valve 122 encircles a flange on a nipple 123 which is screwed into the inner end of the hollow stem 113. The construction is clearly shown in the drawing and need not be elaborated.

While the sleeve 122 may be vulcanized or cemented to the nipple 123, this is a matter of design.

The diaphragm plate 112 is urged to the left and the bushing 118 is held to its seat by a coil

compression spring 124 which is confined between members 113 and 118 under suitable stress and which yields when the diaphragm 111 is subject to pressure. This pressure arrives by way of the port 62 which, as is clearly shown in Figure 1, discharges into the space to the left of diaphragm 111.

Pressed into the bore of the hollow stem 113 and wholly within the ports 116 (so that the latter are not obstructed thereby) is the sanding tube. This communicates through a bore 126 with the sanding passage 63 already described, the sanding passage leading to the space to the left of the guide bushing 117. The tube 125 is further sustained by the radial pins 127. The sanding nozzle tip 128 is threaded into the inner end of the tube 125 and is provided with a flaring discharge port 129 as shown. The parts 125 and 128 enclose a valve chamber in which is freely mounted a ball valve 131. This serves as a check valve to prevent back flow to the tube 125 from the nozzle 128.

Slots 132 cut in the inner end of the nozzle 128 prevent this ball from acting as a valve to resist outward flow from the tube 125 to the nozzle 128.

An equalizing port 133 connects the top of the chamber 89 with a chamber 109 to the right of diaphragm 111. A felt plug 134 is screwed into threads formed in one end of the by-pass port 133 and serves as a sand excluding filter.

The operation of the trap can be briefly traced. Under running conditions, the whole system is vented. With a control relay such as shown in Figure 3, the venting is through the sanding hose 104, but the substitution for control valve 22 (Figure 3) of a valve which would vent the sanding line 48 or the clean-out line 49, or both, is contemplated in certain cases and is mentioned here merely to indicate that the trap is not dependent for operation exclusively on venting through the sanding hose.

When the sanding relay valve 22 reaches the position of Figure 4, air under supply pressure is delivered to the cleanout line 49. Then it passes check valve 78, forces diaphragm 111 to the right and causes the valve element 122 to seal on the bushing 101. The restriction offered by the ports 116 is sufficient to insure response of the diaphragm 111, but air immediately flows through 116 and through the interval between the parts 125, 128, and the hollow stem 113, so that supply pressure is quickly built up in the hose 104 provided the nozzle 105 is at that time clogged. If it is not clogged, there will be no substantial development of pressure. The development of pressure dilates the nozzle 105 if it be clogged and assures immediate clearance thereof.

When the relay valve 122 arrives at the position of Figure 5, the supply air to the clean-out line 49 has been cut off but the check valve 78 prevents back flow. In the position of Figure 5, air is supplied to the sanding line 48 under full pressure and since at this time the valve 122 is closed against the bushing 101, the sanding air will continue to maintain clearing pressure in the sanding hose and nozzle 105 if the nozzle 105 is still obstructed. If for any reason it should fail to clear, no sand can be delivered from the chamber 89 to the hose 104. Assuming, however, that the nozzle was clear at the commencement of sanding or is cleared immediately thereafter, the dissipation of pressure through the ports 116 allows the spring 124 to restore the nozzle to the position shown in Figure 1 so that air from the sanding port 63 discharging through the nozzle 128, 129, will draw air and entrained sand from the chamber 89 and discharge them through the throat 102 to the sanding hose 104 and nozzle 105.

At the termination of sanding, the sanding relay 22 progresses to the position of Figure 6 at which time the supply of air to the sanding pipe 48 is continued and a short impulse is delivered to the clean-out pipe 49. The effect is to force the diaphragm 111 and the nozzle structure to the right, cutting off the flow of sand and causing the last air to sweep the hose 104 and the nozzle 105 clear of sand. This final clean-out is useful because it reduces the tendency for clogging to occur.

During the sanding operation, the stirring nozzle 94 and its compensating slot 96 perform the compensating function already described.

The invention provides a trap which responds very rapidly to and will initiate sanding before a brake application becomes effective, even though the sanding function be initiated by the brake-applying movement of some part of the braking system, such, for example, as the engineer's brake valve or an automatic brake controlling valve device at the head of the train. Both of these schemes of operation are known and neither is illustrated in the present case because it is not a feature of the present invention. Sand is used economically and delivered to the rail with sufficient velocity to ensure effective operation at the angle between the wheel and rail. Flow irregularities which might be induced by vibration, centrifugal effects, and buffing shocks are eliminated, or, at any rate, substantially reduced by the compensating action of the stirring jet.

What is claimed is:

1. In a sand trap, the combination of a chamber for retaining sand; means for supplying sand thereto; a pneumatic ejector serving when in operation to withdraw sand from said chamber; a sanding nozzle to which said ejector delivers sand entrained in a current of air; and a stirring nozzle having an air supply connection and arranged to discharge a stirring jet beneath the lowest level of sand in said chamber, said nozzle having a compensating port arranged to be exposed above the sand more or less accordingly as the level of sand in the chamber is low or high, whereby the activity of the stirring jet is modified.

2. In a sand trap, the combination of a chamber for retaining sand; means for supplying sand thereto; a pneumatic ejector serving when in operation to withdraw sand from said chamber, and also to establish sub-atmospheric pressure in the chamber; a sanding passage to which said ejector delivers sand entrained in a current of air; a stirring nozzle arranged to receive air from the atmosphere and direct it in stirring relation to sand in said chamber; and a restricted secondary inlet for air at atmospheric pressure leading to said chamber above the normal level of sand therein and serving to modify the intensity of action of the stirring nozzle.

3. In a sand trap, the combination of a chamber for retaining sand; means for supplying sand thereto; a pneumatic ejector serving when in operation to withdraw sand from said chamber; and also to establish sub-atmospheric pressure in the chamber; a sanding passage to which said ejector delivers sand entrained in a current of

air; and a stirring nozzle, arranged to receive air from the atmosphere and discharge it beneath the top of sand in said chamber, said nozzle having a compensating port arranged to be exposed more or less accordingly as the sand level in the chamber is low or high, whereby the stirring action is modified to stabilize the delivery of sand to the ejector.

4. In a sander, the combination of means forming a generally cylindrical chamber with its axis approximately horizontal; an ejector throat leading approximately axially from one end of the chamber; a sanding nozzle connected with the discharge end of said throat; an air jet nozzle directed across said chamber toward said throat; means forming a gravity approach passage for sand which passage curves around said chamber and enters the same approximately tangentially from beneath; a stirring nozzle arranged to direct an air jet against the entering sand; and connections for supplying air under suitable pressures to said jet nozzle and stirring nozzle and for supplying sand to said approach passage.

5. In a sander, the combination of means forming a generally cylindrical chamber with its axis approximately horizontal; an ejector throat leading approximately axially from one end of the chamber; a sanding nozzle connected with the discharge end of said throat; an air jet nozzle directed across said chamber toward said throat; means forming a gravity approach passage for sand which passage curves around said chamber and enters the same approximately tangentially from beneath; a stirring nozzle, having an atmospheric supply connection, and arranged to discharge into said approach passage beneath its junction with said chamber; and connections for supplying air under pressure to said jet nozzle and sand to said approach passage.

6. In a sander, the combination of means forming a generally cylindrical chamber with its axis approximately horizontal; an ejector throat leading approximately axially from one end of the chamber; a sanding nozzle connected with the discharge end of said throat; an air jet nozzle directed across said chamber toward said throat; means forming a gravity approach passage for sand which passage curves around said chamber and enters the same approximately tangentially from beneath; a stirring nozzle, having an atmospheric supply connection, directed obliquely downward into said approach passage and discharging against the entering sand flow, said nozzle having a lateral compensating port arranged to be variably blinded by the approaching sand stream according to its depth; and connections for supplying air under pressure to said jet nozzle and sand to said approach passage.

7. The combination of means forming a sanding chamber and a connection for supplying sand thereto; an ejector combining throat extending in an approximately horizontal direction away from one side of said chamber above the bottom thereof; a jet nozzle in the chamber and directed toward said throat; an elastic sleeve of rubber-like material encircling said nozzle normally so positioned as to afford an annular passage to said throat; fluid pressure operated means for deforming said sleeve in such a way that a portion of the sleeve forms an annular barrier between nozzle and throat, and thus isolates said throat from said chamber while said nozzle remains in communication with said throat; and separate connections, one for supplying fluid under pressure to said jet nozzle, and the other for supplying fluid under pressure to said fluid pressure operated deforming means.

8. The combination of means forming a sanding chamber and a connection for supplying sand thereto; an ejector combining throat extending in an approximately horizontal direction away from one side of said chamber above the bottom thereof; a jet nozzle in the chamber and directed toward said throat; an elastic sleeve of rubber-like material encircling said nozzle normally so positioned as to afford an annular passage to said throat; fluid pressure operated means for deforming said sleeve in such a way that a portion of the sleeve forms an annular barrier between nozzle and throat, and thus isolates said throat from said chamber while said nozzle remains in communication wtih said throat; a sand stirring nozzle having an atmosphere supply connection, said nozzle being arranged to discharge air into said chamber; a connection for supplying pressure fluid to said fluid pressure operated deforming means and to said throat simultaneously; and an independent connection for supplying pressure fluid to said jet nozzle.

9. In a sand trap, the combination of means forming a chamber and a passage for delivering sand to said chamber; an ejector throat leading away from said chamber above the bottom thereof; a jet nozzle in said chamber and directed toward said throat; normally open fluid pressure operated valve means for isolating said throat from said chamber while maintaining communication between said jet nozzle and said throat; a stirring nozzle having an atmospheric supply connection and arranged to discharge into the lower part of said chamber; and separate fluid supply connections, one leading to said jet nozzle and the other connected to supply pressure fluid to said fluid pressure operated valve means and to said throat.

10. In a sander, the combination of means forming a sanding chamber and a sand approach passage leading thereto, said passage entering said chamber in a generally upward direction; an ejector combining throat leading away from said chamber above said entrance; a sand pipe to which said throat delivers; a nozzle in said chamber and directed toward said combining throat and shiftable in the direction of its axis toward and from the same; a combined valve and protecting sleeve encircling said nozzle and connected at its forward end therewith, the valve portion thereof serving to close communication between said throat and said chamber around said nozzle when the nozzle is moved toward the throat; yielding means urging said nozzle away from said throat; a movable abutment capable when subjected to fluid pressure to overpower said yielding means and move said nozzle towards said throat; a connection for supplying air under pressure to said nozzle; and a separate connection for delivering air under pressure to said abutment and to said sand pipe.

11. The combination defined in claim 10 in which the path of flow from said separate connection to said sand pipe is by way of an auxiliary passage in the nozzle to and through the throat.

12. In a sander, the combination of means forming a sand retaining chamber and a sand approach passage leading thereto; an ejector combining throat leading away from said chamber above the normal level of sand retained thereby; a sand pipe to which said throat delivers; a nozzle in said chamber and directed toward said

throat; fluid pressure operated motor means for producing relative motion between the nozzle and throat in the direction of the axis of the nozzle; valve means forming at the limit of their approach a seal between nozzle and throat with the nozzle in communication with the throat; yielding means urging said nozzle and throat apart; a connection for supplying air under pressure to said nozzle; and a separate connection for supplying air under pressure to said motor means and to said sand pipe.

13. In a sander, the combination of means forming a sand retaining chamber and a sand approach passage leading thereto; an ejector combining throat leading away from said chamber above the normal level of sand retained thereby; a sand pipe to which said throat delivers; a nozzle in the chamber and directed toward said throat; fluid pressure operated motor means for producing relative motion between the nozzle and throat in the direction of the axis of the nozzle; valve means forming at the limit of their approach a seal between nozzle and throat with the nozzle in communication with the throat; yielding means urging said nozzle and throat apart; a separate connection for supplying air under pressure to said motor means and to said sand pipe; and a check valve arranged to prevent back flow through the last-named connection.

14. In a sand trap, the combination of a chamber for retaining sand; means for supplying sand thereto; a pneumatic ejector serving when in operation to withdraw sand from said chamber; and also to establish sub-atmospheric pressure in the chamber; a sanding passage to which said ejector delivers sand entrained in a current of air; a stirring nozzle, arranged to receive air from the atmosphere and discharge it beneath the top of sand in said chamber, said nozzle having a compensating port arranged to be exposed more or less accordingly as the sand level in the chamber is low or high, whereby the stirring action is modified to stabilize the delivery of sand to the ejector; and means comprising a port of limited capacity for admitting air from the atmosphere to said sand retaining chamber independently of said stirring nozzle.

15. In a sand trap, the combination of means forming a chamber and a passage for delivering sand to said chamber; an ejector throat leading away from said chamber above the bottom thereof; a jet nozzle in said chamber and directed toward said throat; fluid pressure operated valve means for isolating said throat from said chamber without interrupting communication between said jet nozzle and said throat; a stirring nozzle having an atmospheric supply connection and arranged to discharge into the lower part of said chamber; and means comprising a port of limited capacity for admitting air from the atmosphere to said chamber independently of said stirring nozzle.

16. In a sander, the combination of means forming a sand chamber and a sand approach passage leading thereto, said passage entering said chamber in a generally upward direction; an ejector combining throat leading away from said chamber above said entrance; a sand pipe to which said throat delivers; means forming a pressure motor chamber; a tubular member extending through the motor chamber and a portion of the sand chamber and having its end directed toward said throat; a movable abutment connected with said tubular member and working in said motor chamber; a longitudinally elastic sleeve, forming a sand excluding seal between said chambers around said tubular member, said sleeve being connected with that end of said tubular member which is presented toward said throat and being there formed as a valve to afford an annular seal with the throat when shifted toward the same; an annular member forming a combined guide for said tubular member and retainer for said sleeve; a spring reaching between said movable abutment and annular member to retain the latter and urge the abutment in a direction away from said throat; a nozzle housed in said tubular member and directed toward said throat; a connection for supplying air under pressure to said nozzle through said tubular member; a connection for admitting air under pressure to said motor chamber to react against said abutment in a direction to overpower said spring; and means comprising a restricted passage within said tubular member for delivering to the throat a part of the air supplied by the last-named connection.

17. In a sander, the combination of means forming a sand chamber and a sand approach passage leading thereto, said passage entering said chamber in a generally upward direction; an ejector combining throat leading away from said chamber above said entrance; a sand pipe to which said throat delivers; means forming a pressure motor chamber; a tubular member extending through the motor chamber and a portion of the sand chamber and having its end directed toward said throat; a movable abutment connected with said tubular member and working in said motor chamber; a longitudinally elastic sleeve, forming a sand excluding seal between said chambers around said tubular member, said sleeve being connected with that end of said tubular member which is presented toward said throat and being there formed as a valve to afford an annular seal with the throat when shifted toward the same; an annular member forming a combined guide for said tubular member and retainer for said sleeve; a spring reaching between said movable abutment and annular member to retain the latter and urge the abutment in a direction away from said throat; a nozzle housed in said tubular member and directed toward said throat; a connection for supplying air under pressure to said nozzle through said tubular member; a connection for admitting air under pressure to said motor chamber to react against said abutment in a direction to overpower said spring; means comprising a restricted passage within said tubular member for delivering to the throat a part of the air supplied by the last-named connection; and a stirring jet nozzle having an atmospheric supply connection and arranged to discharge approximately at the junction of the sand approach with the sand chamber.

18. In a sand trap, the combination of means forming a chamber and a passage for delivering sand to said chamber; an ejector throat leading away from said chamber above the bottom thereof; a jet nozzle directed toward the entrance end of said throat; a fluid pressure motor subject in one direction to pressure in said chamber and having on opposed working space; an annular valve connected with said motor to be moved thereby in a closing direction when pressure fluid is admitted to the working space of the motor, said valve when closed serving to close the an-

nular interval between the jet nozzle and the entrance end of the throat while maintaining communication between the nozzle and throat; means biasing said valve toward open position; means for admitting air at atmospheric pressure to said chamber; means providing a restricted communication between the working space of said motor and said throat; and separate connections for supplying air under pressure to said nozzle and to said working space.

19. The combination with the structure defined in claim 18 of a one-way valve interposed in the path of supply of pressure fluid to said working space, said valve opening to permit flow to the working space and closing against reflux therefrom.

20. The combination defined in claim 18 in which the connection between said working space and said throat comprises a separate and restricted passage associated with said nozzle.

21. In a sand trap, the combination of means forming a chamber and a passage for delivering sand to said chamber; an ejector throat leading away from said chamber above the bottom thereof; a jet nozzle directed toward the entrance end of said throat; a fluid pressure motor subject in one direction to pressure in said chamber and having an opposed working space; an annular valve connected with said motor to be moved thereby in a closing direction when pressure fluid is admitted to the working space of the motor, said valve when closed serving to close the annular interval between the jet nozzle and the entrance end of the throat while maintaining communication between the nozzle and throat; means biasing said valve toward open position; means for admitting air at atmospheric pressure to said chamber, said means comprising a stirring nozzle supplied with air at atmospheric pressure and arranged to discharge at least partially beneath sand in said chamber; means providing a restricted communication between the working space of said motor and said throat; and separate connections for supplying air under pressure to said nozzle and to said working space.

22. The combination defined in claim 21 in which the connection between said working space and said throat comprises a separate and restricted passage associated with said jet nozzle.

23. In a sand trap, the combination of a sand retaining chamber having a discharge passage; means for supplying sand to said chamber; an ejector type sand discharging means comprising a nozzle and a throat with which said nozzle coacts, said throat being associated with said discharge passage; a pressure operated intercepting valve for closing said discharge passage around said nozzle while permitting flow through said nozzle to said discharge passage; a sanding connection for supplying air under pressure to said nozzle; an impulse connection for supplying air to actuate said intercepting valve; means effective at least when the intercepting valve is closed for delivering air from said impulse connection to said throat and for retaining an operating pressure on said intercepting valve; and valve means controlling the delivery of air under pressure to said sanding connection and to said impulse connection.

24. The combination of a sand trap having a chamber; means for supplying sand thereto; an ejector nozzle and associated throat operable by the supply of air under pressure to the nozzle to propel sand from said chamber; a sanding pipe to which said throat delivers; a pressure operated intercepting valve for preventing discharge of sand from said chamber; a sanding air connection for supplying air under pressure to said ejector nozzle; an impulse air connection for supplying air under pressure to close said intercepting valve; means effective at least when the intercepting valve is closed for delivering air from the last-named connection to said sanding pipe while retaining actuating pressure on said intercepting valve, said means comprising a restricted flow connection; and a controlling valve shiftable from an inactive position in which the supply of air is cut off through a series of three functional positions to said inactive position, in the first of which functional positions it serves to deliver air under pressure to the impulse connection and the second to deliver air to the sanding connection alone, and in the third to deliver air at least to said impulse connection.

25. The combination of a sand trap having a chamber in communication with atmosphere; means for supplying sand thereto; an ejector nozzle and associated throat operable by the supply of air under pressure to the nozzle to propel sand from said chamber; a sanding pipe to which said throat delivers; a pressure distensible self-clearing nozzle through which said sanding pipe discharges; a normally open, pressure operated intercepting valve serving when closed to isolate the sand trap chamber from said throat and sanding pipe; a sanding air connection for supplying air under pressure to said ejector nozzle; an impulse air connection for supplying air under pressure to close said intercepting valve; means effective at least when the intercepting valve is closed for delivering air from the last-named connection to said sanding pipe while retaining actuating pressure on said intercepting valve, said means comprising a restricted flow connection; and a controlling valve shiftable from an inactive position in which the supply of air is cut off through a series of three functional positions to said inactive position, in the first of which functional positions it serves to deliver air under pressure to the impulse connection and the second to deliver air to the sanding connection alone, and in the third to deliver air at least to said impulse connection.

26. A controlling valve mechanism for sanders of the type having a sanding connection to which air must be supplied to cause sanding and an impulse connection to which air must be supplied for clean-out purposes, said controlling valve mechanism comprising a slide valve seat having a sanding port adapted for connection with said sanding connection, and an impulse port adapted for connection with said impulse connection; a ported slide valve on said seat; a graduating valve coacting with said slide valve to control ports therein; means for shifting said valves between two limiting positions, said valve shifting means affording lost motion between the graduating valve and the slide valve; and means for subjecting said valves to pneumatic pressure and thereby supplying air to ports in the slide valve, the parts being so arranged that in one limiting position flow to all ports in the seat is interrupted, as the valve shifting means is moved towards the other limiting position the graduating valve first moves and opens a communication through the slide valve to said impulse port and then the slide valve moves and interrupts such communication and establishes a communication through the slide valve to the

sanding port, upon reverse movement of the valve shifting means toward the normal position the graduating valve first moves and establishes a communication through the slide valve with the impulse port, and finally the slide valve moves to normal position and interrupts communication with both ports.

27. A controlling valve mechanism for sanders of the type having a sanding connection to which air must be supplied to cause sanding and an impulse connection to which air must be supplied for clean-out purposes, said controlling valve mechanism comprising a slide valve seat having a sanding port adapted for connection with said sanding connection and an impulse port adapted for connection with said impulse connection; a ported slide valve on said seat; a graduating valve coacting with said slide valve to control ports therein; the parts being so arranged that the slide and graduating valves control communication to said connections; a piston connected to shift said valves and to afford lost motion as to one thereof; means for subjecting the backs of said valves and one side of said piston to air under pressure; yielding means urging said piston in a direction opposed to the reaction of such air thereon; means forming a working space on the opposite side of said piston; a combined admission and exhaust valve means for subjecting said working space selectively to atmospheric pressure or to the air under pressure reacting upon the backs of said valves; and electrically controlled means for actuating said admission and exhaust valve means.

28. The combination of a source of sand; a sand retaining chamber connected to be fed continuously by said source and to retain the sand against gravity discharge from the chamber; an ejector device including a jet nozzle and a throat alined with said nozzle, the throat forming the exit path for sand from said sand retaining chamber and the ejector device being operable to feed sand from said chamber when pressure fluid is delivered through said nozzle; a sanding pipe to which said ejector device delivers; a pressure operated intercepting valve for interrupting communication between said sand retaining chamber and the throat of said ejector device while maintaining communication between the nozzle and throat; a connection for supplying air under pressure to said nozzle; a connection for supplying air under pressure to actuate said intercepting valve; and valve means for controlling the supply of air to each of said connections.

29. The combination of a sand retaining chamber open to the atmosphere and adapted to inhibit gravity flow of sand therefrom; means for supplying sand to said chamber; fluid pressure operated means for entraining sand and discharging it from said chamber; a sanding pipe to which said discharging means normally delivers; fluid pressure operated means for clearing said sand pipe; and a pressure operated intercepting valve arranged to be closed by the pressure of fluid which actuates said clearing means and when closed serving to isolate said sand retaining chamber from said sanding pipe and from said fluid pressure operated entraining means.

30. The combination of a sand trap having a chamber; means for supplying sand thereto; an ejector nozzle and associated throat operable by the supply of air under pressure to the nozzle to propel sand from said chamber; a sanding pipe to which said throat delivers; a pressure operated intercepting valve for preventing discharge of sand from said chamber; a sanding air connection for supplying air under pressure to said ejector nozzle; an impulse air connection for supplying air under pressure to close said intercepting valve; means effective at least when the intercepting valve is closed for delivering air from the last-named connection to said sanding pipe while retaining actuating pressure on said intercepting valve; a controlling valve shiftable from an inactive position, in which the supply of air is cut off, through a series of three functional positions to said inactive position, in the first of which functional positions it serves to deliver air under pressure to the impulse connection, in the second to deliver air to the sanding air connection alone, and in the third to deliver air at least to said impulse connection; and electrically controlled means for causing said controlling valve to move through said series of positions.

31. The combination of a sand trap having a chamber; means for supplying sand thereto; an ejector nozzle and associated throat operable by the supply of air under pressure to the nozzle to propel sand from said chamber; a sanding pipe to which said throat delivers; a pressure operated intercepting valve for preventing discharge of sand from said chamber; a sanding air connection for supplying air under pressure to said ejector nozzle; an impulse air connection for supplying air under pressure to close said intercepting valve; means effective at least when the intercepting valve is closed for delivering air from the last named connection to said sanding pipe while retaining actuating pressure on said intercepting valve; a controlling valve shiftable from an inactive position, in which the supply of air is cut off, through a series of three functional positions to said inactive position, in the first of which functional positions it serves to deliver air under pressure to the impulse connection, in the second to deliver air to the sanding air connection alone, and in the third to deliver air at least to said impulse connection; and electrically controlled means responsive to a definite change of energization to cause said valve to move from inactive position through the first to the second functional position and responsive to a reverse change of energization to return from said second functional position through the third functional position to inactive position.

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