Oct. 23, 1945. W. M. VENABLE 2,387,423

SNOW-REMOVAL APPARATUS

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Fig. 1

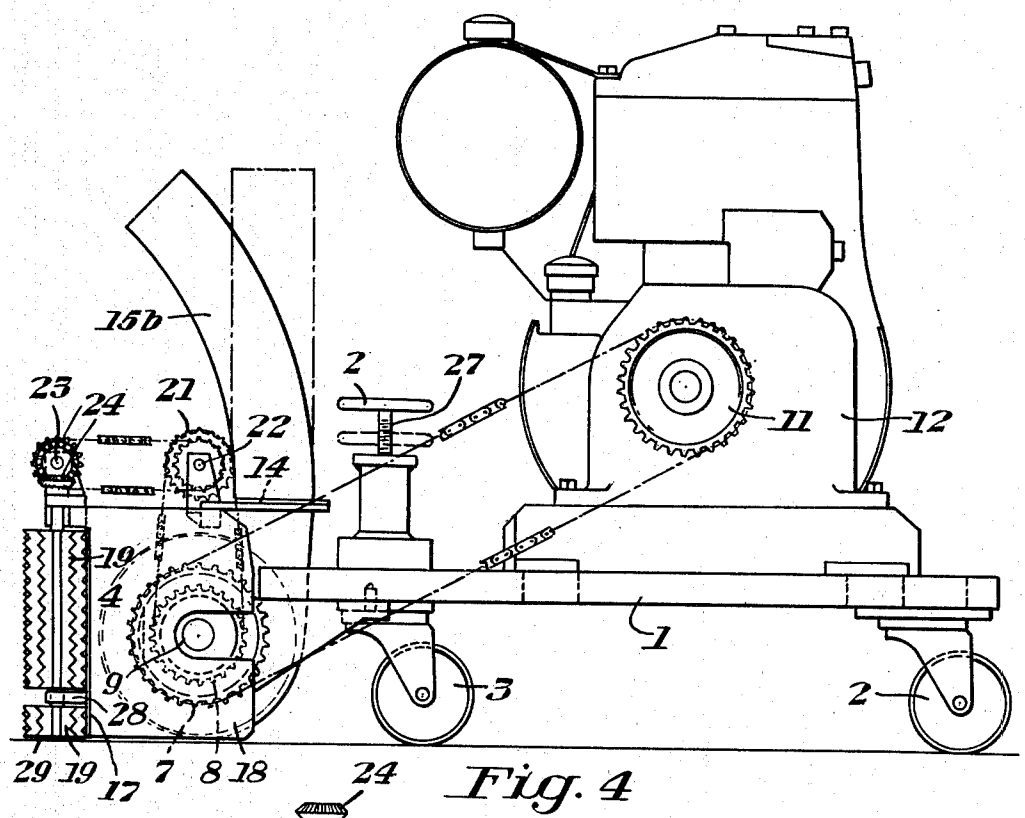
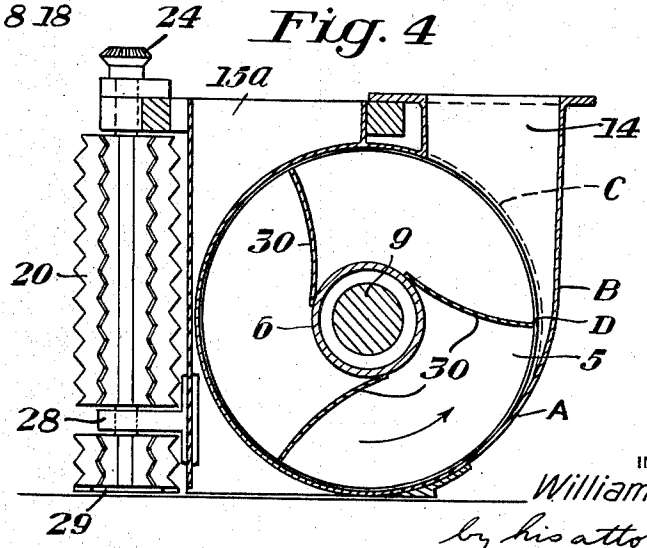



Fig. 4




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Fig. 2.

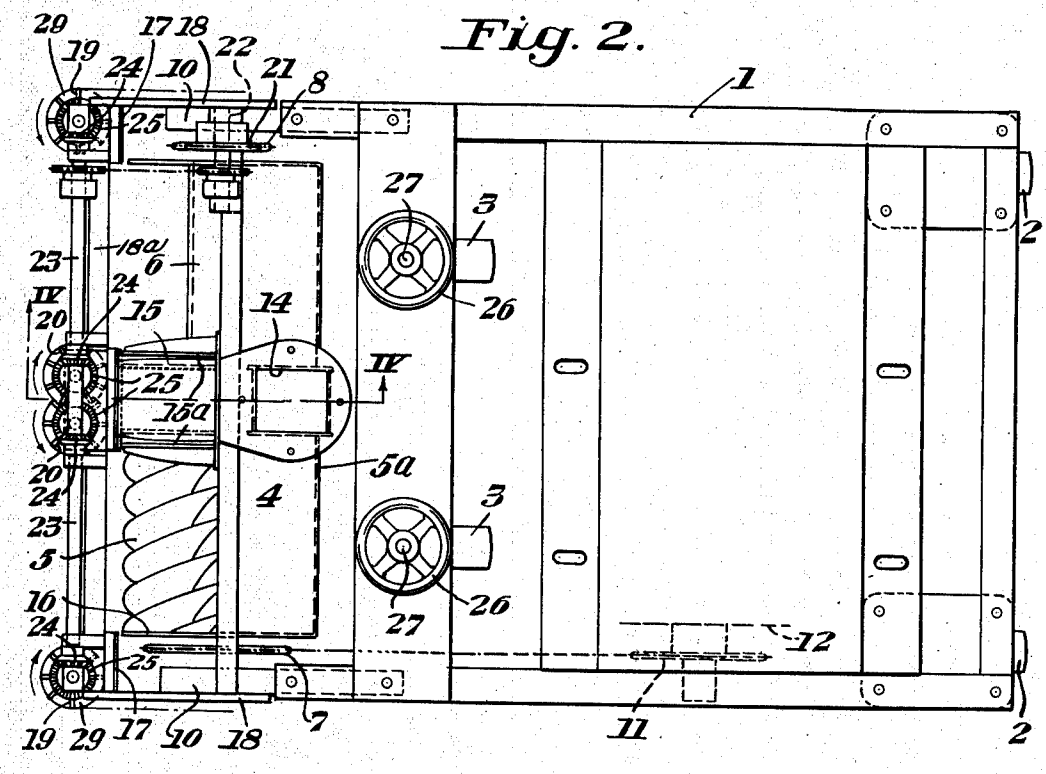
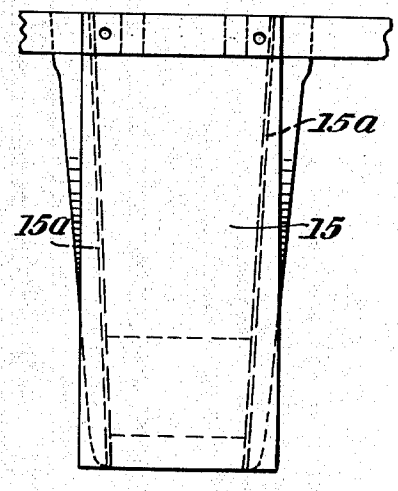
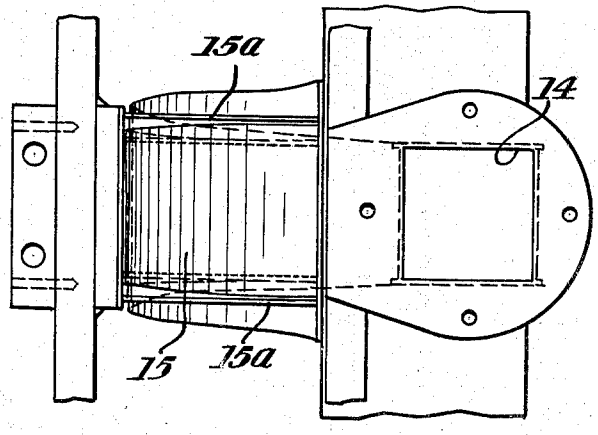



Fig. 2B.

Fig. 2A.




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Fig. 3.

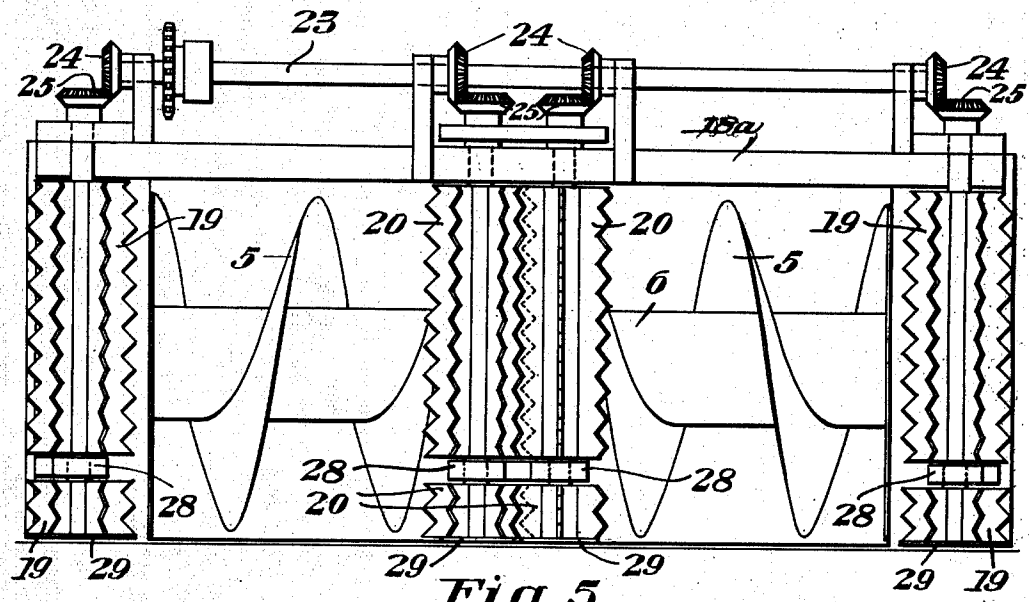



Fig. 5.

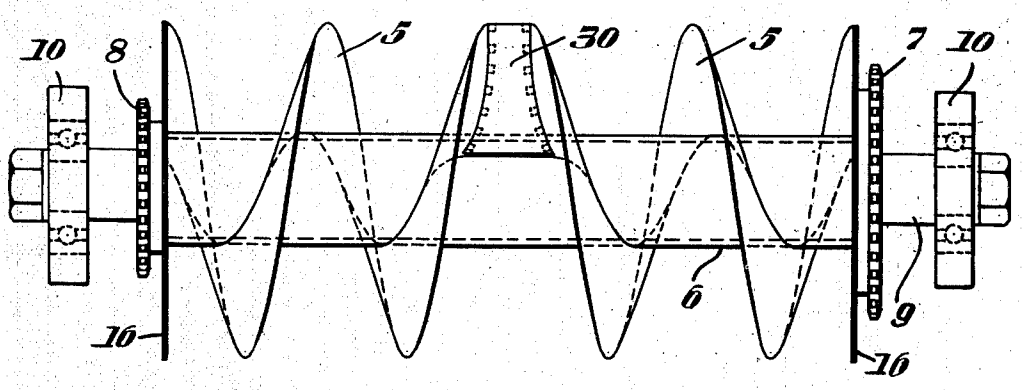
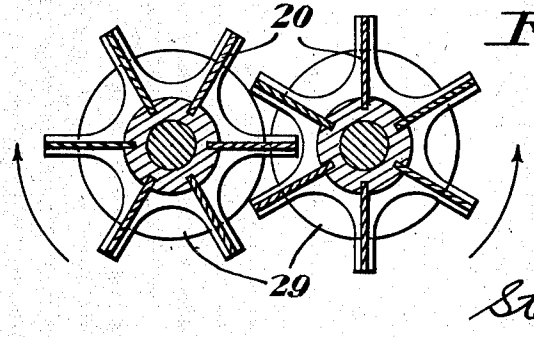



Fig. 6.




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# UNITED STATES PATENT OFFICE

2,387,423

## SNOW-REMOVAL APPARATUS

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Application May 16, 1944, Serial No. 535,827

5 Claims. (Cl. 37—43)

This invention relates to improvements in snow-removal apparatus, particularly to devices of the type in which a rotating thrower member is mounted to revolve between and on the same axis as two feeder screw conveyors designed to convey snow into the rotating thrower member from either or each side thereof.

In such devices the snow is thrown upward at or near to the middle of the rotor, and a deflector or a chute is provided to divert it toward either side of the roadway or path to be cleared, or into vehicles to be loaded. Such chutes or deflectors will be used in connection with the improvements to be described, but the construction thereof forms no part of the invention to be claimed herein. As examples of snow-throwing devices having a thrower axially mounted on the same axis as conveyor members to feed snow thereto may be instanced Patent 1,638,708 to F. Saxon and Patent 2,200,623 to N. S. James.

This general arrangement of conveyor and thrower elements possesses the advantage of greater simplicity of construction than other types of snow throwers in which there is a rotor to throw the snow and other rotors not coaxial with the thrower rotor to feed the snow thereto. But machines of this general type as hitherto constructed have had the following disadvantageous features in actual performance.

(*a*) The amount of power required to operate them is large in comparison with the useful work performed, as measured by the weight of snow thrown a given height or distance.

(*b*) Snow, especially, when it is moist, tends to pack, and "bulldoze" in front of the machine instead of entering the thrower. When this happens the truck pushing the machine forward stalls, and the bank of snow formed in front of the machine thereafter is more difficult to handle.

(*c*) The snow handled by such machines usually has been windrowed by snowplows of other types, and has been somewhat compacted thereby, or by traffic. Machines of this type tend to ride upon the snow instead of cutting it away down to or near to the pavement level.

The primary objects of this invention are to improve the efficiency and capacity of machines of this type, to prevent bulldozing, and to cut the snow to a lower and more uniform grade.

Other objects are to render the machine more easily guided, and to regulate the elevation of the snow-cutting elements above the earth, or pavement from which snow is to be removed.

Minor objects will be apparent to those familiar with this art, and with the minor difficulties encountered in it, some of which arise from the very wide variation in weight of snow per unit volume, compactness and moisture content. The machines should, preferably, be able to handle snow of any consistency at any atmospheric temperature.

The accompanying drawings show one form of this invention which was built for the purpose of trying out in actual operation the features claimed herein, and to determine their merit by comparison with other apparatus. The drawings show all of the features claimed, operatively, but do not indicate proportions of parts or desirable features of structural design necessary in a commercial machine.

In the drawings,

Figure 1 is a side elevation, showing in outline the entire device, including an engine for operating the snow-throwing apparatus;

Figure 2 is a plan view with the engine omitted for clearness;

Figure 2A is a partial plan view showing a portion of Figure 2 to enlarged scale;

Figure 2B is a front elevation of the parts shown in Figure 2A;

Figure 3 is a front elevation;

Figure 4 is a section through the thrower portion of the rotor along the plane of line IV—IV of Figure 2;

Figure 5 is a view of the rotor showing one pair of conveyor screws oppositely disposed, other conveyor screws being omitted for simplicity of showing; and

Figure 6 is a sectional view through a pair of the vertical front cutters shown in elevation and plan in Figures 1 and 2.

Referring for the present to Figures 1 and 2, wherein the general assembly is shown, 1 represents a frame to which all the parts of the device are attached or mounted. The frame 1 is supported upon four casters two near its rear, designated by 2, and two supporting its forward portion, designated by 3. The casters 3 are capable of vertical adjustment, to be described more fully, so that the front portion of the machine, which is to engage the snow to be handled, may be raised or lowered to give it any desired clearance above the road or pavement upon which the machine is to operate.

The rotor which both conveys the snow laterally and throws it vertically is designated in general by 4. As shown in the plan, Figure 2, its length is almost as great as the maximum width of the machine. In a machine intended to work on highways this width is usually fixed

by traffic regulations, and is limited to about eight feet. The width may be whatever is desired, as the proper performance of the machine does not depend upon the ratio of length to diameter of this member.

In Figure 2 the forward portions of helical conveyor flights or screws **5** are shown on one side of the machine, where not covered by a casing **5a** enclosing the rear portions thereof. On the other side, they are omitted to show the tube **6** to which they are secured. In Figure 5 the same element, the rotor **4**, is shown with driving sprockets **7** and **8** attached but with only one pair of screws. The shaft supporting the rotor is designated by **9** and the bearings at the end by **10**. Except for its ends, the shaft is enclosed by the tube **6**.

In Figure 5 and also in Figure 3, the rotor is shown with only one screw on each end, so that the pitch may be more readily observed; but in Figure 2 three pairs of screws are shown, and are likewise indicated in Figure 4. The number of screws on the conveyor portions of the rotor is optional.

The rotor shaft **9** turns in the bearings **10**, secured to the frame **1** in any suitable manner. Ball or roller bearings are preferred. The rotor is driven by a sprocket chain about the sprocket wheel **7**, from a sprocket wheel **11**, on the shaft of the engine **12**. The sprocket chain pitch lines are indicated by broken lines, and the ratios of teeth in the sprockets are such as to give the rotor the desired speed at normal engine speed. It will be understood that intermediate gearing, clutches and transmissions may be introduced, such as good engineering practice may require, for machines of larger capacity. In the machine built according to the drawings, no intermediate clutches were necessary, and the machine required no elements not shown.

As shown in Figures 2 and 3, the forward half of the rotor is open and free to engage snow, except at the middle portions, where the front and top are closed, as shown in Figures 2, 2B and 4, except for an outlet opening **14** through which the snow is to be discharged upward. The front closure is represented by **15**. In Figure 3 the front casing of the middle of the rotor is concealed by the vertical cutters in front of it, but this casing is wider at the top than at the bottom as seen in Figure 2B.

As shown in Figures 2, 3 and 5, the conveyor screws **5** terminate at their ends in discs **16**. The length of rotor between these discs is all that can engage the snow. The driving sprocket **7** is protected from snow by the plate **17** and the side of the machine is protected from snow by the plate **18**, which also forms part of the support for the casing and other mechanism. In Figure 2 the top is shown open, but a cover may be provided. It is omitted from the drawings for the sake of clarity.

If the plate **17** had nothing ahead of it, it would push into and pack the snow in front of it, which is very undesirable. The usual expedient adopted to cover the space required for the drive of a horizontal rotor, whether by sprocket or gear connections, is to provide a wedge-shaped member in front of these parts. This mitigates, but does not eliminate the tendency to pack the snow and to stall the machine. Although a wedge-shaped side cutting edge may be used without sacrifice of other features of this invention, the use of wedge-shaped dividing members at both sides and middle (in front of closure **15**) has been found unsatisfactory, resulting in both bulldozing the snow in front of the machine and causing the machine to ride up in front, upon packed snow, instead of cutting it away. In this invention, this defect is eliminated by the vertical cutter members **19** and **20** which may be used both at sides and in the middle, or at the middle only if desired; but in the middle these cutters or something equivalent to them must be employed to make the machine effective and efficient when operating in wet, packed, or windrowed snow. The upper ends of cutters **19** are journaled in blocks secured to plates **18** and the upper ends of cutters **20** in blocks secured to a beam **18a** extending between the plates **18**.

As a convenient means of operating these vertical cutters in a small machine, I have used the transmission indicated in the drawings, although in much larger machines other transmissions may be preferable. The sprocket wheel **8** is near the end of the rotor opposite sprocket wheel **7**, by which the rotor is driven. From sprocket wheel **8** a chain drive turns a sprocket wheel **21** on a jackshaft **22**, as shown in Figure 1, and another sprocket wheel on shaft **22** drives a sprocket which turns shaft **23** which in turn operates all of the vertical cutters by means of bevel or miter gears **24** and **25**. The shaft **23** is journaled in bearings mounted on beam **18a**.

Referring to Figure 1, it will be seen that the casters **3** may be pressed down with respect to the frame by turning the handwheel **26**, to which is attached the screw **27**. Thus the elevation of the front of machine, including the bottoms of the vertical cutters **19**, and the bottom of rotor **4** above the roadway or pavement to be cleared of snow may be adjusted. The cutters **19** are made to operate as close to or closer to the pavement than the rotor **4**, and they have no shoe or bearing beneath them, so that instead of riding upon the snow they cut the snow away. This is especially important in the middle of the machine where the casing extends entirely around the rotor and therefore has tended to ride up on previous machines in which this element is absent. As will be seen in Figures 1 and 3, the lower bearing **28** for the vertical cutter shaft is some distance above the bottom of the cutter, and the bottom of each cutter terminates in a plate **29** shown in the sectional view, Figure 6, tending to saw the packed snow at the bottom level.

It will further be observed that, as shown in Figures 3 and 6, the two vertical cutters near the middle of the machine, in front of the thrower casing, mesh with one another and turn in opposite directions, so as to throw the cut snow away from in front of the thrower casing, so that it will enter the rotor on each side thereof. The outer cutters, if used, also turn in opposite directions and throw the snow into the space where the main rotor casing is open in front.

The use of vertical cutters at the side of the machine is not broadly new, an early example of such use being shown in Patent 1,393,935 to Bekkerus, who shows cutters having in general helical blades of great pitch. The driving mechanism shown therein is also somewhat similar to that described herein, but the bearing arrangement is different, the arrangement of Bekkerus and of all other devices for the purpose of cutting the side banks in this manner known to me having a bottom bearing. There is usually also a stiffening member or shoe to

reinforce the bottom bearing so that this part of the device may actually slide on the snow or the subgrade. In this invention, any such bottom bearing, sliding member, or shoe is eliminated, one purpose being to cut the snow at a very low level so as not to leave anything upon which other parts of the machine must ride or the wheels of the truck which pushes the machine must ride, thus elevating the front of the machine above the road or pavement upon which it is desired to operate.

While the use of such members at the sides of the machine in front is not basically new, the use of such members in the middle of the machine to permit the full closing of the thrower rotor at that point is broadly new and it is also new to mesh the vertical cutters into one another at that point so that they operate in cooperation with one another, clearing a path immediately in front of the closed portion of the casing for the full height thereof, so that bulldozing in front of the machine, which is a serious obstacle in the design shown in the James patent referred to heretofore, is entirely eliminated. And in addition to this, the compacted or frozen snow in front of the machine is desiccated so that it remains in the properly divided state to be accelerated suitably in the thrower rotor.

As already mentioned and as clearly indicated in the drawings, the rear portion of the thrower rotor, substantially one-half thereof, is provided with a casing 5*a* and the front portion of the rotor is cased only in the middle by the member 15 which, as will be observed, is not of uniform width but is wider at the top than at the bottom. Plates 15*a* form side walls for the member 15 and have semi-circular cut-outs of the same radius as conveyor screws 5. The discharge opening 14 for the casing is shown in vertical section in Figure 4 where it will be noted that at about the point marked A the casing for the thrower opening marked B diverges from the other portion of the casing which is shown in detached lines and marked C, so that radial acceleration of the snow when in the rotor begins to take place at the point marked A, and very appreciable acceleration has actually occurred before the middle of the thrower blades reaches the horizontal position indicated by D. The result of this is that a larger portion of the snow thrown attains the vertical maximum velocity or peripheral speed of the thrower blades, and it is possible to discharge a larger quantity through the rotor than if the acceleration were permitted to take place at the elevation D instead of lower down as at A. Not only is the capacity of the rotor for throwing purposes thus increased, but the efficiency of the device is further increased and the throw of a machine built in this way is practically continuous instead of intermittent—the discharge from one blade commencing before that from another is discontinued. This can be readily understood by considering the construction of the rotor shown in Figure 5 in connection with Figure 4.

Figure 5 shows but one pair of screws oppositely disposed, the right-hand screw being shown on the right hand side and the left-hand screw on the left hand side, these merging into a central radial blade 30 shortly ahead of the point at which the two screws would meet if continued. As shown in Figure 5, this closure blade is very narrow at the periphery of the rotor. It is not desirable to make it any wider than necessary to pass hard lumps of material, principally foreign material which may have accumulated on the pavement and is harder than snow, such as boulders which may enter the machine in actual operation. If some such blade were not placed there to prevent this, but the screws were brought together, large solid fragments could accumulate and be unable to escape. But as will be observed from Figure 5 and with reference to the other drawings, the width of the blade 30 at its periphery is very much less than the width of the outlet 14 through which the snow is to be thrown, so that most of the snow to be thrown does not come in contact with the blade at all but is thrown from the space between the screws where their periphery is much further apart. In fact, the width of the space between the screws from which the material can be thrown is limited only by the width of the outlet opening. It will be further observed that the blade 30 is at its periphery substantially at right angles to the direction of rotation, but at its inner edge is tangential to the tube 6 upon which the screws are mounted so that material to be thrown tends to slide upward and outward on the blade 30 and thus assist complete discharge.

The result of these improvements over former practice is, as has been stated before, that the discharge from this rotor is practically continuous regardless of the number of pairs of screws used. Three pairs of screws are indicated on the drawings, but the machine will function very satisfactorily with only two pairs of screws, and a larger number may be used if desirable on a larger machine. If only one pair of screws is used, the discharge, when the machine is loaded to capacity, in dry snow, still is continuous, though somewhat pulsating. The limitation in the number of screws that may be used is not fixed by the throwing capacity of the rotor but by the space between the outer edges which limits the size of a fragment which can be conveyed by the screw. For instance, if this space in a full sized machine were six inches—that is to say, the pitch of the screws were six inches—it would not be possible for a fragment larger than six inches in its shortest dimension to enter the screw and to be handled by the machine. A larger fragment would have to be cut into smaller fragments before it could enter; and, of course, if the material to be thrown were a foreign material such as a piece of timber, it would not be possible to pass it. This is a practical consideration that must be borne in mind in designing a machine for any specific service.

It will further be noted on examining the drawings that these screws are paired and not staggered with relation to one another as in the case of James, and that regardless of the size or shape of the member 30, material conveyed toward the center can only escape peripherally; it cannot be passed from one side of the machine to the other. This is a distinct advantage for it will not only be observed from examining the design but is actually found in practice that this machine operates with equal effectiveness regardless of the position of the snow pile in front of it which it is required to remove. It does not tend to throw the snow from one side of the machine to the other, and if it is working on one side of a snowbank, would throw the snow just as well as if it were working with a snowbank in the middle of the front of it or on the other side.

Figure 2A shows the closure member 15 of the casing 5*a*. The outlet 14 therein is adapted to

receive a removable deflector duct 15b (see Figure 1) having a sectional size and shape similar to that of the outlet, preferably square. The duct may be so disposed over the outlet as to discharge forwardly or to either side. Regardless of its position, the duct has a tight fit on the outlet.

As already pointed out, the rotor is so designed that the entire periphery of the thrower member can be filled with snow except where it is being cast outward through the outlet 14; that is to say, if the outlet were closed the snow would be conveyed into the rotor from both sides until the space within the rotor were entirely filled and then as the rotation continued the packed snow or ice inside the rotor would turn around as a flywheel of ice. Instead of this, when the outlet from the rotor is open, all of the snow that can escape through the outlet during the rotation so escapes, and this is sufficient to keep the snow from packing tightly in the other part of the rotor. In that part of the rotor which is adjacent the thrower opening, the rotor may be entirely filled with snow around its entire periphery and such snow as is not conveyed far enough toward the center of the thrower to escape through the thrower opening is carried around in the rotor and slides against the front closure 15 of the casing, while doing so moving toward the center of the rotor so that it is cast when it comes in front of the outlet. In order to make this feature effective, the closure member 15 at the upper portion thereof is made somewhat wider than the discharge outlet and at the bottom where it joins the rear casing it is made of substantially the same width as the thrower outlet so that the opening for snow to enter the rotor from in front is wider at the bottom than higher up. It is found in actual practice that this feature materially increases both the capacity of the rotor for throwing material and the efficiency of the machine as a whole.

It will be noted from the foregoing description that the construction of the various members and their means of cooperation is such that there is no tendency for the material to be packed from the time it is first engaged by one of the cutting members until it is passed entirely through the device and thrown. If the material to be thrown is cold, it will be cut up into fragments which remain separate and are of such size that they can readily pass through all of the openings without clogging. It will further be observed that the material once engaged by the thrower rotor, even outside of the thrower casing proper, will be gradually accelerated in the direction of peripheral rotation of the rotor as it is moved toward the center of the machine and the discharge opening, some of this material when the machine is operated to capacity, being carried entirely around the front of the casing of the thrower rotor before it reaches the discharge opening. This gradual acceleration and the practically continuous discharge from the space between the screws makes it possible to attain a much higher efficiency of the device as a thrower so that less power is taken to throw a given amount of material. It will further be observed that the design having a continuous instead of an intermittent discharge and being capable of loading the thrower element to its capacity, is able to handle a much greater volume of material than any machine in which the thrower elements are paddle-like and the throwing definitely intermittent. In this device in the thrower element there is no "batting" of the material; the whole process of acceleration is gradual.

It will further be observed that the construction is such as to enable the machine to cut a path to practically uniform depth throughout the width of the machine, the cutting being as close to the pavement to be cleared of material as safety will permit, and that to adapt it to various conditions of roadway the adjustment of the elevation of the cutting elements is provided for.

The advantages of my invention have been enumerated hereinabove, for the most part, and need not be repeated here. From what has been stated, however, it will be apparent that the invention provides a snow-removal apparatus of simple construction which is highly efficient in collecting snow from a roadway or the like and discharging it through a delivery duct. The apparatus is capable of operating under a variety of conditions and requires no special skill in its operation. The apparatus is also capable of cutting the snow very close to the actual grade of the roadway or other surface.

Although I have shown but a preferred form of apparatus, it will be understood that the invention may be otherwise embodied by changes in the design or arrangement of the elements without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. In a snow-removal apparatus, a frame adapted to move along a roadway or the like, a rotor journaled transversely at the forward end of the frame including one or more pairs of conveyor screws adapted to move snow from both ends toward the middle, the two members of each pair forming closure with one another at the middle, a substantially semi-cylindrical casing extending around the rear side of said screws, with a peripheral discharge outlet in the middle thereof, and a semi-cylindrical closure wall enclosing the front of said rotor opposite to said peripheral discharge outlet, said frame including a beam extending longitudinally of the rotor and disposed forwardly thereof, and a pair of vertical rotary cutters mounted on said beam in front of said front closure wall to divert snow to each side thereof.

2. In snow-removal apparatus a frame adapted to move along a roadway, a rotor with right-hand and left-hand conveyor screws journaled in the front end of said frame and adapted to convey snow toward its middle portions and there cast it upwardly, a casing for said rotor enclosing the rear half of said rotor and provided with an upwardly extending discharge outlet passage at its middle portion, a substantially semicircular closure for the middle portion of the front of said rotor opposite the discharge outlet passage, said frame including a beam extending longitudinally of the rotor and disposed forwardly thereof, and a pair of vertical cutters mounted on said beam, meshing with one another and rotating in opposite directions, to clear snow from the space in front of said front closure portion.

3. In snow-removal apparatus a frame adapted to move along a roadway, a rotor with right-hand and left-hand conveyor screws journaled in the front end of said frame and adapted to convey snow toward its middle portions and there cast it upwardly, a casing for said rotor enclosing the rear half of said rotor and provided with an upwardly extending discharge outlet passage at its middle portion, a substantially semicircular closure for the middle portion of the front of said

rotor opposite the discharge outlet passage, said frame including a beam extending longitudinally of the rotor and disposed forwardly thereof, and a pair of vertical cutters mounted on said beam, meshing with one another and rotating in opposite directions, to clear snow from the space in front of said front closure portion, said front closure being wider at the top than at the bottom.

4. In a snow-removal apparatus, a traveling frame, a rotor journaled horizontally therein adapted both to convey snow axially and throw it radially, a casing enclosing the rear side and a portion of the front side of said rotor, a portion of said frame extending forwardly of said rotor and vertical cutters journaled in said portion of the frame and disposed in front of the front portion of said casing to divert snow therefrom to open spaces in front of said rotor, said vertical cutters having bottom cutting edges at substantially the same level as the lower edges of said casing.

5. In a snow-removal apparatus, a frame adapted to move along a roadway or the like, a rotor journaled transversely near the forward end of said frame, the rotor including a cylindrical core with spaced screw conveyor flights thereon, said flights being paired, right and left handed screws forming closure for each pair at substantially the middle of the rotor, thus adapted to move snow from each side toward the middle and there cast it tangentially to the direction of rotation, a generally cylindrical casing wall closing the front of the middle portion of said rotors, said wall merging into an outlet passage extending upwardly from the rear side of the last-mentioned casing, a portion of said frame extending forwardly of said rotor and a pair of vertical rotary cutters journaled in said portion of the frame and disposed ahead of said front closed casing, the bottom of said cutters being substantially at the same level as the lower edge of said first-mentioned casing.

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