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APPARATUS AND METHOD FOR CRUSHING AND SEGREGATING MATERIALS

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2 Sheets-Sheet 1

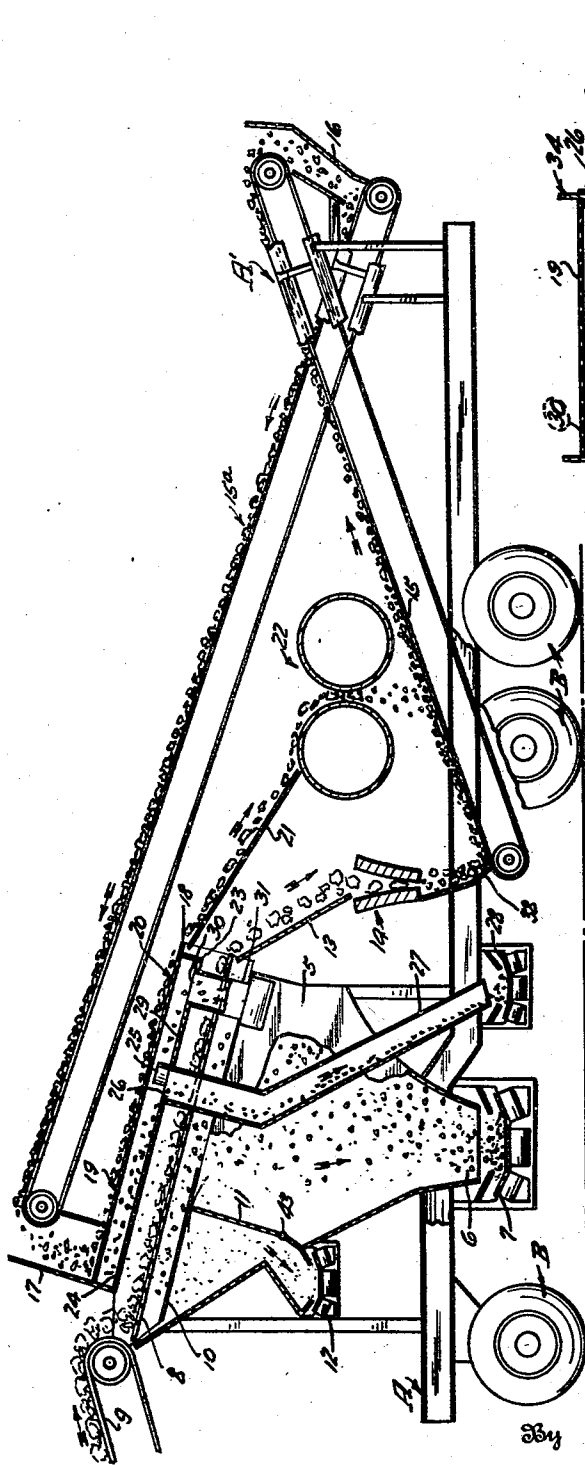


Fig. 1.

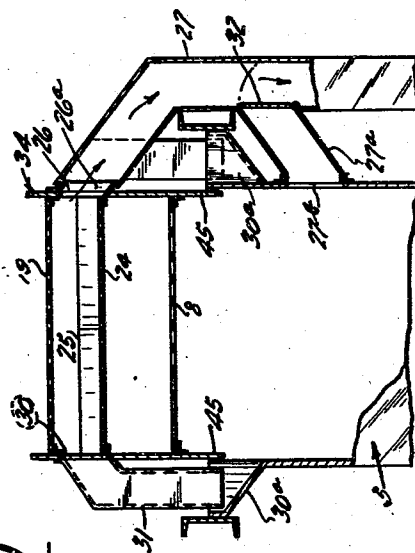


Fig. 2.

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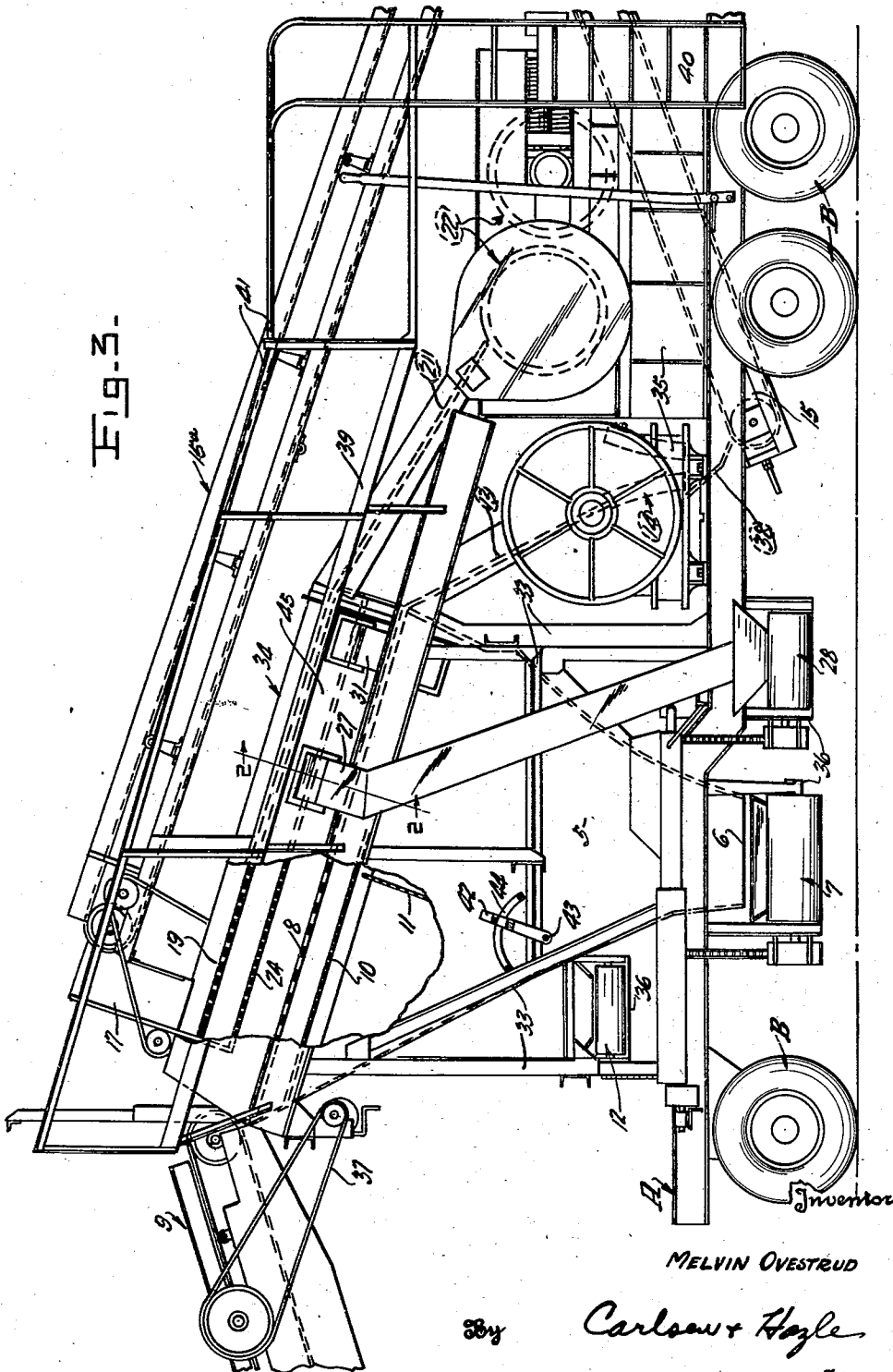
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UNITED STATES PATENT OFFICE

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APPARATUS AND METHOD FOR CRUSHING
AND SEGREGATING MATERIALS

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8 Claims. (Cl. 83-93)

This invention relates generally to an improved apparatus and method for crushing stone, rock and similar materials and segregating the crushed material in desired sizes.

The invention particularly aims to provide an improved apparatus and method for the provision of a crushed stone aggregate for use in the construction and maintenance of highways. In work upon highways of the kind having a hard surface composed of a mixture of bituminous or asphaltic oils and crushed stone aggregate it has been found that one of the very important component ingredients is a specially prepared and sized crushed rock aggregate known popularly under the name of "chips." These chips are made by crushing the rock to a comparatively small size, so that, for example, the chips will pass a screen having one-half inch square openings but will be retained upon a screen having one-quarter inch square openings. The resulting material when used on the highways has the very desirable features of increasing traction and offering better visibility as is commonly appreciated.

However, in the construction of such highways, particularly in regions remote from rock or gravel crushing plants, it has been found very costly to purchase the required chips. Even though the construction or maintenance project may have in operation at the site a portable rock crushing plant of the usual type, the cost of producing such chips is prohibitive. This is due, first, to the fact that the tightening down of all crushing elements of the plant so retards production that the operation cost, per ton of chips, is very high; and second, to the fact that the very nature of the chips requires that all material of less size than, for example, one-quarter inch, must be screened out and wasted. This loss or wastage in actual practice amounts to the order of forty-five percent of the actual material. The net result is such a high cost of production that the chips are usually bought from some remote plant where special equipment is used, or where they occur as a by-product, and here the final cost to the user is high due to the relative scarcity and the transportation required.

The primary object of my invention is, therefore, to provide an apparatus and method for producing a percentage of chips as a concomitant of the regular crushing operation and production, and at the same average cost as the regular aggregate used in such highway work. Another object is to provide a means for producing such chips in a portable crushing plant and in any reasonable desired quantity relative to the normal

output of aggregate. A further object is to provide an improved crushing method making possible the better handling and crushing of the material and particularly suited to the production of such chips in the quantity desired.

These and other more detailed and specific objects will be disclosed in the course of the following specification, reference being had to the accompanying drawings, in which—

Fig. 1 is a diagrammatic view of a crushing plant showing the essential crushing and conveying elements thereof and with my invention incorporated therein.

Fig. 2 is an enlarged vertical cross section through the screen assembly used in screening out the various sizes of materials, this view being taken approximately on the line 2-2 in Fig. 3.

Fig. 3 is an enlarged side elevation of the main portion of the plant, with a side fragment broken out to show interior construction.

In describing my invention reference will first be had to the diagrammatic showing of Fig. 1 in which reference character A designates a frame and B the wheels upon which said frame is supported for transport purposes.

Supported on the frame A is a large delivery and mixing hopper 5 which dumps at its open lower end 6 into a side delivery conveyor 7 for carrying off the crushed aggregate. Above the large upper end of the hopper is mounted a vibrating screen unit in which a total of three and one-half decks or screens are provided, all of said screens being, in the assembly here shown, inclined lengthwise or endwise to cause the material to travel towards their lowermost ends, although said screens may be horizontal if desired.

The lower full deck or screen 8 is the initial receiving deck for the raw material, which is dumped upon the upper end of the deck by a conveyor 9 leading from the gravel pit or feeding hopper (not shown), or, of course, by any other suitable feeding means. This deck is preferably made of square mesh screen having a mesh size selected to pass the largest particles or rocks desired in the aggregate and such particles, as well as all smaller ones, will therefore fall through this deck and directly into the hopper 5 effecting the first separation of the material.

A sand screen or lower half deck 10 is arranged in the screen unit below the upper end portion of the deck 8 and is of fine mesh to pass only small sand particles and divert all larger particles off its lower end into the hopper. Sand passed by this screen 10 is diverted by an ad-

justable wing or gate 11 out from an end of the hopper 5 to a side delivery sand conveyor 12.

The material rejected by the raw material receiving deck 8 is carried off the lower end thereof by an inclined chute 13 to a substantially centrally located primary jaw crusher 14 of conventional form, and the material is therefore reduced to smaller size by action of this crusher. Such material then falls from the jaw crusher 14 to a conveyor 15 which carries it upwardly in a direction away from the hopper 5, to a point over the end of the frame A, the material being then dumped from the upper end of this conveyor down through a chute 16 to another conveyor 15a which returns it in the reverse direction upwardly over the screen unit and hopper.

Material thus crushed and returned to the screen unit is caused to fall through a chute 17 upon the upper end of the uppermost, crushed material receiving deck, or screen 18 of the screen unit. This deck 18 has screens of two different sizes, the upper end section 19 having mesh openings, for example one-half inch square to pass material of the maximum size desired for chips, and the lower end section 20 having openings of substantially the same size as those in the deck 8 to pass material of the maximum size required in the aggregate.

Material rejected by this deck 18 is caused to flow by gravity off the lower end and over an inclined chute 21 which leads to a conventional secondary roll crusher 22 located over the conveyor 15. The material is thus further comminuted and is returned by conveyors 15 and 15a to the upper deck 18 for final separation. Properly correlated adjustments of the jaw and roll crushers 14 and 22, which adjustments may be made while the machine is in operation, will effect the necessary relative stage of reduction in each, to the point that all material recirculated to the screens will be finally passed out to the various delivery conveyors.

The chip size material passed by the upper end section 19 of the upper deck 18 falls to an intermediate deck 23 in which is incorporated, below said section 19, a fines removing screen 24 of one-quarter inch mesh, for example, and which is thus adapted to pass all of the material of less size than the minimum required for the chips. These fines drop to the raw material receiving deck 8 through which they pass into the hopper 5, as a component part of the delivered aggregate.

The material rejected by the screen 24, all of chip size, is diverted by a baffle 25 through a side delivery port 26 to a chute 27 which leads down alongside the hopper 5 to a chips conveyor 28 delivering the material laterally, as shown.

The material passing through the lower section 20 of the upper deck 18 falls upon a blank section or platform 29 of the intermediate deck 23, from which it is diverted laterally through side ports 30 to by-pass ducts 31 leading the material to the hopper 5 below the deck 8.

The general operation of the machine will be readily apparent from the foregoing, and it will be appreciated that the crushed material delivered to the hopper 5 through the various screens will be of the proper mixture required for highway construction and repair. The relative sand content may be varied as required by adjusting the gate 11. It will be further noted that, with the exception of the small quantity of fines removed by screen 24 from the chip material, and of the sand passed by screens 8 and 10, that none

of the material is caused to pass through more than one screen and all screens work constantly at maximum effectiveness.

Under most circumstances the amount of chips required in the work is a small part of the total volumetric quantity output of the machine. This works as an advantage in that the production of the chips, as a by-product of the machine, will not remove too much of the component material of chip size required in the aggregate. Only one port 26 and spout 27 are shown in the drawings, and the amount of chips delivered may be varied by use of a damper 32 in the spout as shown in Fig. 2 if so desired, the material, as this damper is opened, being diverted to flow through a fork 27a of the spout back to the hopper through port 27b. However, it is obvious that delivery spouts for the chips may be used at each side of the screen unit if so desired.

The apparatus thus described permits the practice of a new method in the crushing and separation of stone and like material. This involves feeding the raw material onto a lower screen deck of a mesh size suitable to pass the largest particles required, screening out from beneath this lower deck a variable portion of the fine material or sand, conducting the material rejected by the lower deck to a primary jaw crusher for initial crushing, returning such crushed material to an upper crushed material receiving screen deck having a receiving end portion of a mesh size designed to pass all material of chip size or smaller, screening out the fines from such chip size material and returning them to the lower deck, delivering the materials rejected by the fines removing screen for use as chips, screening out at a lower portion of the upper receiving deck all particles of a size equal to the maximum size required in the crushed product and carrying them by a by-pass means beneath the lower deck for mixing and delivery, conducting all particles rejected by the upper deck to a secondary roll crusher for further crushing, and finally recirculating these crushed particles to the upper receiving deck. This method of crushing, screening, circulating and recirculating the material, aside from advantages such as the full use of all screens, balanced load on the respective crushers, and other features, also is of extreme advantage in the production of chips since the chip size material is screened out at substantially a mid point in the entire operation after at least one crushing operation has taken place. Thus material of chip size in the raw material will always be carried into the final aggregate mixture to retain the proper relative component sizes in the aggregate. Then after at least one crushing operation has taken place a separation is made to remove chip size material and deliver a variable quantity thereof for use. There are thus at all times two full screen decks producing finished material with a portion of one deck producing, if desired, the chip size product with separate delivery means.

Referring particularly to Figs. 2 and 3, the mechanical assembly of the machine will be described in more detail, the machine shown being one of practical construction and well adapted to illustrate my invention. The hopper 5 is supported on the frame A with suitable supporting parts and frame members designated generally at 33. The various screen decks as heretofore described are arranged in a screen unit 34 which is placed in the frame over the hopper 5 and which is given a vibratory motion by any suitable

and well known operating means (not shown). The jaw crusher 14 and roll crusher 22 are arranged in the assembly in substantially the positions shown, and are of the conventional construction including large housings 35 which are rigidly affixed to, and serve as a part of, the entire frame assembly.

The conveyors 7, 12, and 28 for aggregate, sand, and chips respectively, are all of the conventional belt type and are supported by brackets 36 beneath the respective delivery means and are laterally arranged to deliver the materials out to the side of the machine. Conveyor 9 is shown as being also of the conventional belt type and may be driven as indicated at 37 from driving parts of the machine, this conveyor of course being inclined upwardly from the pit or other feeding point. The return and recirculating conveyors 15 and 15a are of the belt type, the first receiving material from both the jaw crusher 14, guided by the short pan 38, and the roll crusher 22, and delivering to the lower end of the second through a chute 16. Said chute is of course laterally or angularly extended since the conveyors 15-15a operate alongside each other, and the delivery chute 17 is similarly inclined to lead the material properly back to the screen unit 34. Suitable supporting framework (A' in Fig. 1) is provided for outer ends of the conveyors 15-15a and the chute 16. Inspection of upper working parts is provided for by provision of a platform 39, steps 40 and railings 41 in accordance with usual practice in such machines.

The sand gate 11 is adjustable from the side of the hopper by means of a lever 42 connected to the rock shaft 43 of said gate and working over a quadrant 44 as shown.

The screen unit 34 has spaced side panels or members 45 between which the screens or decks are mounted as shown in Fig. 2, and the chip delivery port 26 is formed in one of these side members with the spout 27 slidably embracing flanges 26a around said port in the manner clearly shown. The by-pass ducts 31 are also secured on these side members 45 over ports 30 therein and are extended downwardly alongside the screen unit loosely into flared portions 30a of the hopper to conduct all product-sized material from the upper deck to the hopper.

It is understood that suitable modifications may be made in the structure as disclosed, provided such modifications come within the spirit and scope of the appended claims. Having now therefore fully illustrated and described my invention, what I claim to be new and desire to protect by Letters Patent is:

1. The method of crushing and separating rock material, which includes the steps of initially screening the material to remove particles of all sizes less than a selected maximum, crushing the material rejected in this step of the method, screening the crushed material separately from the first screening step to remove a product of substantially uniform size less than the maximum resulting from said initial screening step, screening out the fines from said product and joining them with the smaller sized material of the first screening, and finally delivering said product separate from all other materials.

2. The method of crushing and screening a rock product to provide an aggregate and chips of a substantially uniform size smaller than the largest of said aggregate, which comprises screening the rock product to remove particles of both aggregate and chip size, crushing the rock prod-

uct rejected in this screening, screening the crushed product to remove therefrom material of chip size and smaller, screening out said last mentioned fines from said chip size crushed material, and separately delivering the chip size material independently of the aggregate and chip size material resulting from the first screening.

3. The method of crushing and screening rock to provide an aggregate and chips of substantially uniform size smaller than the maximum size of said aggregate, which comprises initially screening the rock to remove therefrom both the material of aggregate size and any material of chip size in said rock, crushing the rejected rock, screening the crushed rock to first remove material of chip size, and smaller, and then to remove material of larger size within the range of sizes required in the aggregate, screening out the fines from the crushed chip size material, separately delivering the chip size material secured after crushing, and conducting and mixing the said fines and the said material of larger size directly to and with the aggregate and chips secured by the initial screening.

4. In a rock crushing and screening apparatus, a conveyor for raw materials, a screen unit having a main screen for receiving material from the conveyor and screening out materials of an aggregate size, means for crushing material rejected by the main screen, an upper screen arranged over the main screen, means for returning crushed material to said upper screen, the said upper screen having openings in one portion for removing chips of a size smaller than the largest particles of the aggregate, and said upper screen also having openings in another portion for removing particles of size suitable for the use in the aggregate, an intermediate screen having openings in one portion for removing fines from the chips and having an imperforate portion for receiving the larger material of aggregate size from the upper screen, means for delivering the chip size material from the intermediate screen independently of the aggregate, and means for conducting the aggregate passed by the upper screen around the main screen for admixture with the aggregate passed by said main screen.

5. In a rock crushing and screening apparatus, a conveyor for the raw material, a screen unit having three large and one small superimposed screens therein, the lower larger screen of said unit being adapted at one end to receive material from the conveyor and separate out particles of aggregate size, the small screen being disposed beneath said lower screen for removing a portion of the sand-like particles from the aggregate, means for crushing material rejected by the lower screen, means for returning said crushed material to the uppermost large screen of the screen unit, the said upper screen having openings in the portion receiving the crushed material for passing material of a chip size and smaller and having openings in another portion for passing larger particles of aggregate size, the intermediate screen between upper and lower screens having openings in one portion for screening out the fines from the chip size material and depositing said fines on the lower screen, the said intermediate screen also having a blank portion for receiving aggregate size material from the upper screen, means for separately delivering chip size material from the intermediate screen, and means for conducting aggregate size material from the intermediate screen for mixing with the material passed by the lower screen.

6. A rock crushing and screening apparatus for screening out material of aggregate size and a smaller material for use as chips, comprising a screen unit having a plurality of screens, means for conducting the rock first over one screen for removing an aggregate including material of chip size as a component part, means for crushing material rejected in the first screening, means for conducting said crushed materials over another screen, independently of the movement of material over said first mentioned screen, for first removing material of chip size and smaller and then removing larger material for use in the aggregate passed by the first screen, means for screening out the fines from the crushed chip size material and returning them to the first mentioned screen, means for separately delivering the crushed chip size material after the fines are removed therefrom, and means beneath the screen passing the crushed material larger than chip size for bypassing this material around the first mentioned screen and mixing it with the material of aggregate size.

7. A rock crushing and screening apparatus for separating an aggregate and a smaller chip size material from a raw rock material, comprising a screen unit having a plurality of screens, means for first conducting the raw material over one screen for separating out an aggregate which includes material of chip size as a component part, means for crushing raw material rejected by the

screen, means for conducting the crushed material over another of said screens for separating out material of chip size and smaller, means for screening out the fines from said chip size material, means for separately delivering the chip size material after the fines are removed, means for returning the fines from the chip size material to the aforesaid aggregate, and means for screening out aggregate size material from the crushed material subsequent to removal of the chip size material therefrom.

8. The method of treating rock material to produce an aggregate of particles heterogeneously sized up to a predetermined maximum and a separate supply of particles of substantially uniform size but smaller than such maximum, which comprises removing from the raw rock material all particles of greater than predetermined aggregate size, thus leaving an aggregate mass composed of all sizes up to such predetermined size, crushing the removed relatively large particles, removing from the crushed particles all particles of a substantially uniform predetermined size that is smaller than said predetermined aggregate size and delivering said uniformly sized particles separately, the balance of said crushed material of a size not greater than said predetermined maximum being returned to the material forming said aggregate mass to be comingled therewith.

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