valve, c^1 , which is provided with a sample cock, and is connected with a conduit that unites, through the pipe, c^2 (Figs. 1 and 2), all the returns of water in a single automatic purging apparatus, X (Fig. 1).

Each heater is surmounted by a thalpotasimeter, c^3 (Fig. 20), with a dial, which shows the temperature of the juice within. The pipes in which the water and juice circulate are of cast iron, and are of $5\frac{1}{2}$ inches internal diameter. Three valves, S, S', and S'', in a line above each diffuser, serve to regulate the flow of the juice and water in the apparatus. The first of these, S, serves for introducing the water circulating in the pipe, m , under pressure into the diffuser that is being emptied. The second, S', belongs to the circulation, and remains constantly open between the diffusers. The third, S'', lets out the strong juice, and puts the diffuser whence the latter is issuing in communication with the pipe, m' , which leads it to the gauging backs, T. These latter (Fig. 2) are located on the same floor with the diffusers. They are provided with graduated scales to show how full they are, and with cocks that permit of sending the juice to the apparatus in which it is to be treated with boneblack.

The exhausted slices of beets, when the bottom of the diffuser is opened, fall into a large masonry funnel, and are carried along by water to the lower extremity of the chain, E, which raises them up to the presses. The waste water passes through a perforated plate of iron that forms one of the sides of the trough that the base of the lift enters, and is forced by a pump, M (Fig. 2), to the beet washers.

The Presses.—The presses, two in number, are of the Bergreen pattern. One of them is shown in section in Fig. 22. It consists of an iron plate cylinder, P,

filled with sliced beets while another is being emptied, the latter will be receiving the direct pressure of the water, its valve being open in order to allow the latter to enter through the pipe, m . The valve, S', is closed, and all the other diffusers have their valves closed, save those (S') that set up communication with the heaters. A current is thus established between the water back and one of the diffusers (which we shall designate as No. 1), through its upper and lower part, by means of the elbow, x , at the upper part of No. 2, and passes through heater No. 1 and the valve, S', of No. 2. The same is the case with diffusers Nos. 3 to 12, which latter communicates with the upper part of No. 13 through its heater and the valve of No. 13.

If all the valves of No. 14 are closed, there will be no circulation, for want of an exit. In this case, the valve of one of the gauging backs, T, is opened, after the juice valve, S'', has been opened, and the juice will then flow from No. 14 through the pipe, m' . After a certain quantity of the juice has been extracted, the valve of the gauging back is closed, as is also that of diffuser No. 1, which will be thus isolated. After this the pressure is transferred from No. 1 to No. 2 by opening the water valve No. 2. During this time diffuser No. 14 has been filled with fresh slices, and we now proceed to introduce juice at the bottom, since the introduction of it at the top would produce a subsidence that would interfere with the operation of the apparatus. To effect such introduction, it is only necessary to open the juice valve, S' (Fig. 17), of No. 1, when the juice will, through it, enter heater No. 14, which communicates with diffuser No. 14 through the lower part, x^2 , x , x' . During the charging of No. 14 with juice, the air cock, s^2 , is opened, as is also the water cock, y (Fig. 18), at the

THE TREATMENT OF SEDIMENT-CARRYING MOUNTAIN STREAMS IN EUROPE, AND ITS APPLICATION TO CALIFORNIA.*

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Introductory Remarks.—The debris question, so important to the interests of this State, is full of interesting features. It is of such intricate and complicate nature that only the most careful and impartial investigations of all the conditions bearing upon it can bring about its successful solution. The desire to contribute a small share to such has moved the writer to investigate what has been done in reference to sediment-carrying rivers, torrential streams, etc., in other parts of the world. The Alps in the southern and central part of Europe afford the best opportunity to study this question, as they have a great many such water-courses, which have damaged and partially continue to destroy the valleys by raising by the river bed and destroying adjoining agricultural lands by erosion or filling in. Certain portions of these, however, have been very successfully improved by comparatively simple and inexpensive means. The source of the detritus there is natural wash, and in no case hydraulic mining.

In California the conditions are somewhat different, since the natural as well as the artificial source of the detritus must be considered. Appreciating fully this difference, it is nevertheless apparent that a study of the works of European engineers, in reference to the permanent improvement of sediment-carrying water-courses, cannot fail to be of service to those engaged in the solution of this question in California. Taking advantage of this experience, and modifying their

FIG. 10.—Root Cutter. FIG. 11.—Plan of the same. FIGS. 12 AND 13.—Knives. FIGS. 14-16.—Details of Rollers. FIG. 17.—Heater and Diffuser. FIG. 18.—The same seen from above. FIGS. 19-21.—Details of the same. FIG. 22.—Press.

DUJARDIN'S DIFFUSION APPARATUS.

which incloses another, P², containing rectangular apertures and surmounted by a hopper, P³, in the interior of which revolve two superposed truncated cones, Q and Q'. The latter of these, Q', is cast in a piece with spirally arranged arms, which are so inclined as to compress the slices and push them toward the bottom. On a line with this, the lower cone, Q (which is cast in a piece with a helix), revolves in an opposite direction.

This double revolution in opposite directions is produced by two bevel wheels, M and M', driven by the shaft, n , which is provided with a pulley, N, and a pinion, n^1 , which gears with the wheel, N¹. To this effect, the upper cone, Q¹, is provided with a hollow cylindrical part that passes through a bush in the cross piece, O, which connects the sides, O¹, that support the shaft, O²; and this cylinder carries the wheel, M, through which motion is communicated to it. The same is the case with the lower cone, Q, which is prolonged by a hollow axle that passes through the interior of the first, and receives at its upper part the wheel, M', whose pinion, keyed in an opposite direction to that of the wheel, M, causes the cone to revolve in a direction contrary to that of the other.

The slices make their exit at the lower part of the press through an annular orifice whose diameter is regulated by a ring, q , and screws, q^1 . It is upon the diameter of this passage that depends the pressure exerted by the helices on the slices. The liquid that traverses the perforated cylinder is received in the jacket, P, and flows externally through elbows that are connected by the pipes, Q².

Operation of the Apparatus.—If we suppose the plant in full operation, that is, that one diffuser is being

bottom of the same diffuser, in order to destroy all internal pressure; and after this, the lower door being opened, the slices will be carried along by the surrounding water to the cistern of the chain, E'. Then a washing is effected by opening the water valve, the lower door is closed, and fresh slices are put in.

During this interval, the liquid has reached the level of the mouth of diffuser No. 14, which we close, and at the same time open the air cock, s^2 , on its cover, D². When the liquid begins to issue through this cock, we close the latter, as also the juice valve, S², of No. 1, and open valve, S¹, of No. 14. The current, which was before flowing upward, now becomes reversed, and flows downward. Then, by opening the valve of the gauging back, we extract a new quantity of juice, and afterward produce a pressure upon No. 2, as we did before upon No. 1; and the operation continues without interruption.

In order to set the plant in operation, a certain number of the diffusers are filled with water, and the steam cocks, c , of the heaters are opened. When the water has reached the requisite temperature, the following diffuser is filled with sliced beets, and we proceed as if the plant were in full operation, removing no juice until it has reached the desired aerometric degree.—*Publication Industrielle.*

The Angler mentions a mixture which is recommended for keeping off mosquitoes and gnats, which abound in moist districts. It consists of three parts olive oil, two parts oil of pennyroyal, one part glycerine, and one part of ammonia. It is to be well shaken before applying to the face and hands, and it must not be allowed to get into the eyes.

measures according to local conditions, more satisfactory results will be obtained than if the same were ignored. No originality is claimed for that part of this paper, still the writer hopes that it will be agreeable to the members of the Technical Society, and will give rise to a thorough and careful discussion and investigation on the part of this society of one of the most important questions in California.

Characteristics of Torrential Streams.—Before entering upon an account of the remedies applied, it is necessary to look into the general nature of torrential streams.

1. **Origin.**—The constant influence of the atmosphere, the rains, snows, hail, and dews, and the changes of temperature, all affect the materials of which the mountains are composed, and cause a continuous disintegration of the surfaces, which are washed down subsequently by the falling rain. This occurs most rapidly there where the soil is not protected by vegetation. The flowing water cuts a channel in which the detritus is carried to the lower valleys. The disintegration and erosion progresses then more rapidly. The water undermines the slopes; these, losing their equilibrium, slide into the water-course, and are carried away by the water. The bed becomes wider and deeper, new tributaries are formed until a large number of them cover the whole watershed.

2. **Classification.**—The torrential streams can be classified conveniently as follows:

a. **Simple Torrential Streams**, having but one main gorge or valley into which a smaller or greater number of secondary tributaries issue.

* From Transactions of the Technical Society of the Pacific Coast. Read July 11, 1884.—*Eng. News.*

b. *Compound Torrential Streams*, which have two or more main gorges or valleys, or are composed of several simple torrential streams.

c. *Fan-shaped Erosions* on the slope of the mountains. Here one deep erosion is fed by a large number of smaller ones; they are generally dry, except during the rainy season.

3. *Subdivisions*.—To whatever class the torrents belong, they all show three or four distinct subdivisions:

a. *Region of Erosion*.—Collecting basin, A, B, C, in Fig. 1. This comprises the upper part of the watershed, where the water and the products of disintegration and decomposition are collected, and from which, both combined, are carried into, b, *region of transportation* (a b in Fig. 1), which serves as channel-way to transport the water and the detritus into the, c, *region of deposition* (b c in Fig. 1), which is raised continuously

FIG. 1.

by the settling of detritus; d, *channel of discharge* (c d in Fig. 1), carries the water from the region of deposition, where it left its coarser detritus, to the main river. This section, however, is sometimes missing. All these subdivisions can occur several times in one and the same water-course.

4. *Action of the Water in Torrential Streams*.—During the dry season, most of these streams are harmless. As soon, however, as warm winds cause a sudden melting of the snow, cloud-bursts occur or a long-lasting rain sets in, the erosion becomes immense. A chaotic mass of debris, gravel, rocks, and boulders is carried down by the water to the valley. The volume of the sediment is sometimes several times larger than that of the water. In the beginning all the different classes of detritus are carried along with the same velocity. Soon, however, the large detritus will attain a greater velocity on account of its volume, and will deposit itself wherever a sudden decrease of the grade occurs. The other material will lodge behind them, at first in a general disorder, but later on in the order of their respective dimensions. The region of deposit will then assume a convex profile. If, then, the volume and the power of the water should become greater, a reversed action commences, i. e., that of the separation of different sized detritus. The water carries now each kind of detritus separately with a velocity inversely proportional to its size. The result is that the fine material will be deposited at the lower edge of the region of deposit, and the coarser at or near the apex of the same. The longitudinal profile of this region will then assume a concave form, i. e., it will be steeper toward the source. This change from a convex to a concave profile will occur after each large rainstorm or melting of snow. The convex profile proves that the stream has just come to a comparative rest. In this way the region of deposit will always be replenished, its grade will constantly increase until finally all the material carried to it by the stream loses its equilibrium and is carried farther down the valley. The grade on which this will occur is called the "profile of equalization." Then only such masses of detritus are transported from the upper region as the region of transportation can carry away. This corresponds to a continuous transportation of detritus in both regions, necessitating cessation of the above mentioned increase in the grade of the region of deposit.

But this state is not a permanent one, for as soon as

FIG. 2.

the water becomes clearer, and enters the region of deposit without being charged with detritus, then a similar process of erosion and transportation will take place, by which the surface of the region of deposit will be lowered more and more, and its slope will become gentler. This will continue as long as the grade is steep enough for the water to carry off the detritus. When, however, the limit of this is reached, and the transporting power of the water and the resistance of the river-bed balance each other, then the stream has "worked out," or becomes dormant; it will discharge only clear water, and the stream has adopted its final profile, the "profile of equilibrium." The profile of the region of transportation is always a concave curve at its lower end. It may, however, have a profile which does not fit into such continuous curve. This is

the case when the erosion has reached the bed rock at several points. Then smaller or larger falls are formed, which interrupt the regularity of the profile. Below and above such places the regular concave profile will exist.

Means of Improving Mountain Streams.—In order to improve torrential streams in a permanent manner, it is necessary to determine:

1. How the formation of detritus can be prevented, or at least be decreased?

2. How the detritus can be stored near its sources?

The leading principle of any improvement is to attack the evil at its very source. Small slides and erosions, in their first state of formation, can be stopped easily at little cost; but if allowed to attain larger dimensions, they become rapidly more powerful, and require much more extensive and costly works.

The improvements requisite are—

1. Such as will prevent the sudden and rapid collection of larger quantities of rain water. This is accomplished by the planting of forests and the raising of grass and underbrush near the sources of the water-courses. Vegetation protects the soil against the mechanical effects of the rain; the roots bind the soil together, and the fallen leaves and the grasses retard the flow of the rain water; the plants absorb the same, and store it for a continuous and regular supply of the springs and water-courses. This will prevent the sudden rises of the rivers.

2. The protection of the shores against undermining, and the bed against erosion. This is principally done by the erection of "Thalsperren." The German word for these structures has been retained, as it is more significant and comprehensive than the English expression "restraining wall." It includes works that are not walls, but have the same duty, but in a less degree.*

A thalsperre is a structure erected across the bed of a stream, to diminish the grade of the same, and to decrease the power of the water; also to raise and thereby widen the bed, and to retain or store detritus. A distinction is made between "dead and live thalsperren." The first are built of rock or timber, and the latter of hurdle work and fascines, made of green branches. The latter have the advantage over the former that their resisting power will increase from year to year, as the branches drive their roots into the river-bottom, and the growing twigs oppose greater obstacles to the water. The thalsperren of rock are either curved or straight. They can be built of either dry masonry, or of masonry in mortar, or both. Wooden thalsperren should be used only where stone or rock cannot be obtained economically.

If a series of thalsperren has been built so that the line connecting the foot of the upper one with the top of the lower one corresponds to the profile of equilibrium, i. e., the grade on which the water is not able to carry away any more detritus, then it is evident that the detritus carried by the torrent will lodge above the thalsperren. If these thalsperren are sufficiently high, and the river bed has been widened by the deposits, and the water is compelled to run in the center of the thalweg, away from the shores, then the problem of the permanent improvement of the torrent is solved.

But as the grades of the torrents are generally very steep, the distance between two such thalsperren would be very short, and the number of thalsperren necessary to arrive at the desired result very great, which would involve a heavy expense. Therefore, all that can be accomplished is to create the profile of equalization, and then construct such other additional works, which will prevent the erosion of the deposits and the undermining of the shores.

Such works consist generally of strong hurdles erected lengthwise equidistant from the center line of the thalweg or the future river-bed, and of cross-hurdles, placed at regular distances, forming steps, the upper edges of which lie in the line of equalization. To prevent undermining of the cross-hurdles, they should not exceed 15 feet in height, and the toes should be protected with rocks. The brush in the hurdles soon takes root and sprouts, thereby securing the river-bed and breaking the power of the high water. The space between the longitudinal hurdles and the shores must be filled with earth, and be planted with willows set in rows under an angle of 45° with the center line of the torrent. Finally, trees driving deep and strong roots should be planted.

When stone is abundant, the hurdles are replaced by small thalsperren (23 feet high) of dry masonry (rustic thalsperren).

The works so far outlined have been employed successfully in France; they, however, refer principally to that class of mountain streams which derive their detritus solely by undermining the shores and eroding their own bed.

The other class of mountain streams, which receive their detritus from large accumulations of rocks, formed by the disintegration of the mountains or by glacial action, require additional works to neutralize the damaging influence of the continuous supply of material. These consist in the retention of the same near its source or, if this is not possible, in its storage near the foot of the mountains. The remedy in the first case is a restraining dam, a large thalsperre (in contradistinction to this kind, the previously mentioned thalsperren are called "consolidation thalsperren"), built up in the mountains, or, in the second case, a storage reservoir for the detritus on the talus of the torrent or at some other convenient place. As the restraining dams are built for the purpose to store as much detritus as possible, it is important that they should be built below places with gentle grades and of large lateral extent. They must be constructed so that they can be raised from time to time, by either putting a new section upon the thalsperre, continuing the same slope, or by building a new one a little back of it. This latter method has the advantage that by the succession of steps the power of the falling water is broken; also that in case of injury or break of one of the steps, the whole work is not endangered. The above-mentioned storage places have the purpose to receive all the detritus not restrained by the upper thalsperre. They consist of dams or levees, inclosing a larger or smaller area, with a waste-gate at the lower end, through which the clear water runs off. When the place is filled with detritus, trees are planted, and another storage place is prepared.

* The definition of the word "Thalsperre" is, a structure which closes up a valley. "Thal" is the German word for valley, and "sperren" to "close up."

Drainage of Sliding Slopes.—Permeable ground resting upon impermeable substrata frequently slides after a rainfall. To prevent this, the rain water should not be allowed to percolate the ground, which has been accomplished successfully by means of drainage channels or ditches. In one instance in France, four large ditches were excavated with a grade of 15 feet in 100 feet, into which a number of secondary drain ditches emptied. The main ditches were about 3.28 feet deep and 2.2 feet wide in the bottom. The bottom was well paved and the ditch then filled up, first with large stones, then with coarse gravel, and finally with fine gravel. The secondary drains were constructed similarly; they were 2.3 feet deep and 1.3 feet wide in the bottom.

These drainage works have been very successful when used in time, and great expense saved thereby.

FIG. 3.

They should be made as near as possible to the sources in the high mountains where slides have caused small depressions, and which are liable to retain large portions of the rainfall and snow. In the perimeter of Sanieres the cost of such drains was:

		Secondary ditches.
Excava. per 1 running ft., main ditches.....	7 cts.	2 cts.
Pavement per 1 running ft., main ditches.....	3 cts.	1.5 cts.
Filling per 1 running ft., main ditches.....	1.6 cts.	5.5 cts.
	11.6 cts.	9.0 cts.

Similar drainage ditches have been used extensively in Austria, and, when constructed properly, have been always successful in preventing the formation of slides.

Protection of Very Steep Slopes.—To secure and protect very steep slopes, a series of narrow horizontal berms with vertical slopes and the bottom inclined toward the mountain along the side hill (Fig. 3) are cut. A laborer places plants upon the berms, m, n, so that their roots are about 4 inches distant from the outer edge; he then covers them with a little earth, which he takes from the slope, o, t. Another laborer prepares meanwhile the next higher berm, and throws the dirt excavated upon the first berm until the same is completely filled. This operation is repeated until the entire slope is secured. After two or three years the ground filled in is fit to be planted with fir trees. The

FIG. 4.

ground between the fir trees is used for grazing (Fig. 2). The cost of these berms, including planting, was 53 cents per 100 running feet.

Treatment of Very Steep Parts of the Stream.—Where the grade of the torrent is too steep to allow the erection of regular thalsperren, a construction was used which is shown in Fig. 4. The entire work was of dry masonry, with the exception of the thalsperre, which formed the base of the whole system and was built in mortar. In the case illustrated, the original grade of 37 feet in 100 feet was by this means reduced to 11 feet in 100 feet.

In those instances where one shore consisted of solid rock, and the other of loose material, spurs of dry masonry were built, by which the current was forced over to the solid rocky shore.