SURFACE-CONDENSER FOR STEAM STREET-CARS.

By W. R. ROWAN, Randers, Denmark.

THIS invention consists of a surface-condenser that fits under the car-seats or other unoccupied space about the car, and is connected by a narrower part running under the floor, and thus connecting the two parts under the car-seats.

To facilitate the condensation of the exhaust steam from the engine, a fan or blower is employed, of any ordinary construction, to pass or force a rapid current of air through the tubes, and thus cool them.

The drawing represents a vertical section of a car with the condenser in position. A represents a car provided with seats B and suitable floor C. Under said seats and floor is arranged the surface-condenser D, and filling up, as nearly as possible, the entire space under said seats. To the bottom of the condenser may be attached the pillow-blocks or bearings *d d* for the axle E and wheels F F, it forming part of the car-body, if desirable.

A space, *b*, may be left around the sides of the condenser, and either filled in with non-conducting material, or it may be an air-space for the circulation of air.

The condenser may form the seats, sides thereof, and the floor, and may be made of iron in one piece, or riveted together out of sheets, and secured to the car itself in any suitable manner, forming, in fact, the lower part of the car-body.

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The great advantages of this condenser will be readily appreciated by those familiar with the art, and they are: large condensing surface arranged in a very small and compact space; the condenser is out of the way, and may form part of the car-body itself; the space hitherto unoccupied in street and similar cars is made use of to condense the exhaust steam, by which horses are frightened when it is allowed to escape into the atmosphere, besides causing sparks to be thrown into the air and streets, or to cause confagurations of combustible material; the condenser is very simple, and may be constructed in any suitable manner and of any suitable material, to occupy substantially the space shown and described.

COMBINED STEAM-ENGINE AND STEAM VACUUM-PUMP.

By GEORGE R. GLEASON, Beloit, Wis.

FIGURE 1, side elevation; Fig. 2, vertical section; Figs. 3, 3' common clock-valves; Fig. 4 is a top or vertical view of the parts indicated by the letters C', B, and C, including the cylinder-heads of the pump, as shown at Fig. 1; A A, cylinders of the pump; F F F, the bottom plates of the pump-cylinders; V V are induction-valves, and *l l* are valves leading to the induction-pipes; D is a pipe for supplying water to the injecting-pump C and the boiler feeding-pump C' through the pipes *e e*, with which the pipe D connects, as shown, in the direction shown by the arrows. B is a steam-cylinder, supplied with steam by the pipe *a* through the steam-chest *c*, from which steam is admitted to the chambers or main cylinders A A through the pipes E E. L is a walking-beam, connected with the floats *x x* by means of the adjustable rods *o o*, stop-collars *h h*, and which floats, by means of said rods and walking-beam, operate the cut-off valve V² by means of the valve-stem and arm V³. C is a double-acting pump, for injecting water into the cylinders A A through pipes H H. C' is a single-acting pump, for feeding the steam-boiler through pipe *b*. *r r* is a piston stem or rod, provided centrally with a piston-head P, having expansion packing rings *d d*, as shown, and at either end having a water-piston head, *d' d'*, all as shown. *i i* are perforated hollow globes, connected to the lower ends of the pipes H H, for the purpose of breaking the water into spray when being forced into the cylinders A A.

The cylinders, and all other parts for which cast-iron is available, are made of that metal. The piston-rod *r r* is of steel, the rods *o o* of brass or other suitable metal, and the floats *x x* are made of sheet-copper or other available material, all manufactured and finished in the usual style of the machinist's art. The pump is started or put into working operation by first turning on steam through the pipe *a*, admitting it to the steam-chest *c*. The cut-off valve V² is then set in motion by means of hand manipulation of the walking-beam L, thus operating the valve V² by means of the arm and valve-stem V³, alternately admitting to and cutting off steam from the right and left-hand ports to the steam-cylinder B, as shown, and when steam is thus admitted to said cylinder the piston-rod *r r*, upon which is rigidly fixed the piston-head P, provided with expansion packing-rings, as shown, is caused to reciprocate to the right and left by regular alternate strokes, as shown, and which will be readily understood.

The piston-rod *r r* also has a suitable head or plunger rigidly attached at each end, marked *d' d'*, and it will be seen that when set in motion, as hereinafter described, the piston-heads P and *d' d'* all co-act and discharge their respective proper functions at the same time, causing the pumps C and C' each to draw water through the pipe D and branch pipes *e e*. A suitable and regular supply of water is then, with concentrated force, injected by the pump C, through pipes H H and perforated globes *i i*, into each of the cylinders A A alternately. The pump C', at the same time, forces a regular and sufficient supply of water into the steam-boiler through the pipe *b*. When the pump has thus been set in motion by hand-power, as before described, a supply of steam being in readiness for working the whole mechanism of the device, steam is admitted through the pipes E E into the cylinders A A, regularly alternating with the injection of water into said cylinders, as hereinbefore described. The alternating supply of steam through pipes E E is regulated by the lateral action of the piston-head P, thus discharging the function of a valve. The action of the piston-head P (acting as a valve) and the strokes of the pump C produce exactly equal alternating admissions of steam and injections of water into each of

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the cylinders A A, and as soon as the steam and water thus admitted and forced into either of the cylinders A A, as before described, come into contact with each other, a vacuum is instantly formed, at once causing the cylinder to fill with water forced in by atmospheric pressure from the well or reservoir through the induction pipe V, and the float *x* in the cylinder, thus filled, will be carried upon the surface of the water to the top of the interior of the cylinder; and while one of the cylinders is thus being filled, the water in the opposite cylinder is being expelled therefrom by the force of steam admitted thereto, as aforesaid, through the outlet port *l*, and when the water in said cylinder shall fall below the stop-collar *h* upon the rod *o*, the weight of the float *x*, acting by its gravity upon said stop-collar *h*, causes the steam to be cut off and reversed to the opposite port of the cylinder B, as shown, and thus causing the operation above described to be repeated.

The rod *o* may be adjusted by means of thumb-screws in the ends of the walking-beam L, so as to check the downward movement of the floats *x x* at any desired point, and by this means the pump may be caused to work at any percentage or degree below its maximum capacity; and this is a feature in my invention of great importance in an economical point of view.

The floats *x x* are made a trifle smaller than the interior diameter of the cylinders A A, for the purpose of preventing downward pressure of steam upon their upper surfaces, all fitting loosely upon the rods to permit them to move freely up and down thereon.

The pump C' enables me to dispense with the use of a separate pump to supply water to the steam-boiler, as heretofore used in steam vacuum-pumps, thereby saving much expense.

GRINDING AND POLISHING.

By JOSHUA ROSE.

No. 1.

ARTICLES of metal requiring to be polished require to have the surface removed before the polishing can be performed, because the materials used in polishing are too fine and cut too little to reach the fine hollows upon the surface of the articles.

Grinding may be aptly termed the first stage of polishing, because a ground surface has a certain amount of polish to it, and the finer the grinding the greater the polish. Grinding, however, as generally understood, is the operation of removing by abrasion the outer surface sufficiently to remove the forged or cast surface, and thus prepare the work for the polishing process.

The appliances used in grinding are first the grindstone, which is of large diameter for ordinary or flat work and small when the surface of the work requires to be concave, as in the case of razor grinding. The stones are run at a high speed, and kept wet with water. The work is performed with the stone running from the operator. It is of great importance that these stones should run true, because in that case the work can be performed much more rapidly and true. An instance of this occurred some years ago, when a large railroad company desired to have the surfaces of their locomotive guide bars fitted up by the piece. The work, which, together

with the fitting of the guide blocks, had been costing about ten dollars per engine, was taken by one of the workmen for \$8.00, which price was paid for a period of about a year. During this time there had been made several experiments with a view to grind the bars as true as possible. The method adopted was as follows: The stone upon which the operation was performed was about 4 feet 6 inches in diameter, and ran at about 300 revolutions per minute. The bars were held upon the stone so that the grinding marks ran crosswise of the stone; hence the width of the face of the bars would grind concave unless the bars were given a slight motion. This, however, the grinder so successfully performed, that with a surface plate to test with, he managed to grind the surfaces so true that it took more work to efface the grinding marks than it did to finishing the truing of the surfaces; notwithstanding that the top as well as the bottom bars were made, both on the inside edges as well as on the faces, very true to a surface plate, and it was required that the finishing should be done with a superfine smooth file, and that no scratches should be left in the work. To save the work entailed in filing out the grinding marks, which latter proved very destructive to files, it was first attempted to grind the bars length-

wise on the stone; but this was found impracticable, inasmuch as it was not possible, with the utmost of care, to grind the surfaces flat. The stone was made as true as possible and the experiment repeated, but still the faces of the bars were rounding, entailing a deal of extra work to true them before commencing the draw-filing. The next experiment made was to grind them crosswise of the stone and true to the surface plate, and then draw them lengthwise along the stone, performing just sufficient grinding to alter the direction of the grindstone marks. This, too, proved a failure, because the stone not being quite true—and it is impracticable to keep such a stone true—the bar would jar and tremble upon the stone, and the motion would cause the face of the bar to become rounded. In course of time, however, the machinist left the shop, and estimates for the job were tendered by many others among the workmen. One, however, offered to do them—that is, the eight guide bars and the four guide blocks—for \$4.00 per engine. This price was considered too low to enable the workman to deliver good work and make day wages, let alone the customary \$2 per day, which was allowed for piece-workers. He, however, had the bars ground crosswise of the stone and trued as usual, after which he drew them lengthwise along a stone running so slowly that the inequalities of the stone did not cause the bars to jar or tremble in the least; and so no matter if the stone was half an inch out of true, it would not affect the truth of the bar faces. By this simple expedient he saved one half of the work, and earned on the bars and blocks, for over ninety locomotives, an average of 2.3¢ a day, or 30 cents a day more than had been earned when more than double the price was paid. The difference, however, is made more apparent by considering the time taken to perform the work, which was by the first workman an average of about 4½ days per set, and by the second workman in a little over 1½ days. The edges of the bars were rounded to a ¼ inch radius and the corners of the guide blocks were filed to fit those of the bars. The shop in which this took place employed at least 100 men upon vise work, and yet none of them perceived the manner in which this saving was effected; so that after the second workman left that shop no one could be found, not even among the apprentices, many of whom had served five or six years at the trade, to take the work at the same price. This circumstance occurred ten years ago, and the simple expedient above described has not, even yet, been discovered.

The method of truing large stones true is by hacking them, which is performed as follows: The stone is run at a speed of about 100 revolutions per minute, while the operator resting his hand upon the grinder's seat or saddle holds a piece of coal or chalk so closely to the stone that it will touch the high spots, and by moving the position of his hand he makes across the face of the stone a series of marks about ¼ inch apart, and made upon the high places only.

The distinctness of these marks informs the operator of the amount necessary to take off in order to true the stone. To do this he stops the stone, and taking an implement, such as shown in Fig. 1, strikes the stone as with an axe, crossing the cuts as shown in Fig. 2, in which A represents a grindstone, B, B, B, B the circumferential marks made by the piece of coal, and denoting the high spots of the stone, and the diagonal marks on B, B, B, B, showing the hacking marks, which are mere indentations. It will be observed that the hacking marks are heavier and closer together at 1, 4, and 5

than at 3 and 2, the latter being the lightest and widest apart. The reason of this is that the truing marks show the heaviest at 1 and 4 and the lightest at 2, and the hacking is therefore performed most at 1 and 4 and least at 2. It will be also observed that the hacking does not altogether remove the high places, but removes a large proportion of the area, so that the places hacked wear away more rapidly than the rest of the surface of the stone. The hacking not only serves to keep the stone true, but it sharpens it so that it will cut more freely; for if the surface of the stone gets smooth it will not cut freely. At times the surface of a stone will get glazed, through being used on soft metal, as the particles of the metal will adhere to the face of the stone; to remedy which the grinder takes a piece of round bar iron, about an inch in diameter, and holding it against the stone with its length standing at a right angle to the cutting face, he forces it against that face with great pressure, resting it against the face of the horse, and forcing it to the stone with a piece of wood hollowed out at the end to form a bearing in which the bar may revolve. The piece of iron should be a foot, at least, longer than the width of the cutting face of the stone, so that one end will be long enough to permit of being guided by the left hand, which must not grip the bar but steady it only, permitting the bar to revolve, as it will do from the friction of the stone. While this operation is being performed, the stone should be kept well supplied with water, and the bar should be given lateral movement across the face of the stone. The pressure with which the bar is held to the stone is by some made intermittent, by which means the action is claimed to be more efficacious. Both brass and cast-iron work dull the stone very quickly.

For purposes in which the work is not required to be of standard sizes, the grindstone is a valuable tool, because it will cut much more rapidly than a file, and where the quantity of metal to be taken off is small, much more rapidly than a planing machine; and since the work requires no setting, it possesses, for such purposes, a very great advantage, in the matter of time, over a planer, because the position of the work can be moved in the hands almost instantaneously: on small work this is highly beneficial. Then the stone being worked with water applied the work does not get hot, and hence difficult to handle, as is the case with using solid emery wheels, so that hardened work, which could neither be filed nor planed, may be ground without becoming softened at all. A skilful grinder will do a great deal of work, and make it

segments should be put on in one day, and they should be on as quickly as possible after the glue is applied, so that the latter shall not get cold. So soon as each segment is put into its place it should be clamped firmly to its seat and driven firmly up to the joint of the next one, and when the layer is completed it should be left clamped all night to dry. In the morning one clamp should be removed, and that section fastened by boring a small hole and driving therein round and slightly tapered soft-wood pegs of about $\frac{1}{4}$ inch diameter. The whole of the sections being pegged the next layer of segments may be added, and so on until the required width of wheel is attained. The whole wheel should then be kept two days before it is turned, and as little as possible should be taken off in the turning process. The circumferential surface should be turned slightly rounding across its width, and as smoothly as possible. It is practicable to proceed with the construction of the wheel without nailing between the various operations so long as here advised, but the wheel will in that case be more apt to get in time out of true. To cover the circumference of the wheel sole leather is used, its thickness being about $\frac{1}{2}$ inch; it should be put on soft and not hardened by hammering at all, and with the flesh side to the wood. The joint of the leather should not be made straight but diagonal with the wheel-face, the leather at the edge of the joint being chamfered off as shown in Fig. 4 at A, and the joint made diagonal, as shown in Fig. 5 at A.

If the leather was put on with a square butt joint there would be apt to be a crease in the joint, and the emery or other polishing material would then strike the work with a blow, as well as presenting a keener cutting edge, which would make marks in the work no matter what pains might be taken to prevent it. This, indeed, is found to occur to a slight extent upon very fine polishing, even when the joint of the leather is made as above; and the means taken to obviate it is to not put any polishing material on the immediate joint and to wipe off any that may get there, leaving $\frac{1}{16}$ of an inch clear of polishing material. It is obvious that in fastening the wheel to its shaft it should be put on so that it will run in the direction of the arrow, providing the operator works with the wheel running from him, as is usually the case with large wheels, that is to say, wheels over 18 inches in diameter. In any event, however, the wheel should be put on so that the action of the work is to smooth the edge of the leather joint down upon the wheel, and not catch against the edge of the joint, which would tend to rough it up and tear it

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true and of ordinary uniformity of size. For large flat surfaces, however, such as the plates used in safe-making, the grindstone can not be so profitably employed, because the operator can not see where the stone is cutting, and has to keep reversing the plate to see how the operation is proceeding; then again, the water from the stone, together with the grindstone grit, diffuses over the surface of the plate, rendering frequent wiping necessary, and a heavy or large plate is an awkward thing to handle, requiring the employment of two or three men, and even then the work can not be performed with much exactitude, because of the grinding being performed out of sight; for such purposes, therefore, a solid emery wheel is the best. It is slung in a wooden frame pivoted upon a shaft hung in bearings, and with provision to give the emery wheel a swinging and horizontal movement, the latter by means of perpendicular adjustment, which operates automatically from a slight vertical pressure. The work lies horizontally with the face to be operated upon upwards, and the emery wheel, which is usually about 2 feet diameter with about a 4 to 6 inch face, revolved at a high speed by suitable belting, is brought into contact with the face of the work and operated over it, the amount of pressure of the wheel to the work being regulated by the hands upon the frame carrying the emery wheel.

POLISHING WHEELS.

Of polishing wheels there are several kinds. First those of wood with a leather face. These are built up of sections of wood fastened together by gluing, and with wooden pegs in place of nails or screws. The joints of the sections or segments are broken—that is to say, suppose in Fig. 3 that 1, 2, 3, etc., up to 8 represent the joints of the 8 sections of wood forming one layer of the wheel, the next 8 sections would have their joints come at the dotted lines A, B, C, etc., up to H. The thickness of these sections is usually made of hard, well-seasoned, soft wood, such as pine, and to prevent them from warping after being made into a wheel it is advisable to cut out the sections somewhere near the size in the rough and allow them to lay a day or two before planing them up and fitting them together, the object being to allow any warping that may take place to do so before the pieces are worked up into the wheel, because if the warping takes place afterwards it will be apt to throw the wheel out of true, whereas it is necessary that these wheels be very true, not only so that they may not prove destructive to their shaft-bearings, but that they may run steady, and not shake or tremble, and because the work can be made much more true and smooth with a true than with an untrue wheel. Only one layer of

apart. The leather should be glued to the wheel, which may be slightly soaked first in hot water. The glue should be applied very hot, and the leather applied quickly and bound tightly to the wheel with a band. One end of the leather may be first glued to the wheel and fastened with a few tacks to hold it while it is stretched tightly round the wheel, the leather itself should be softened by an application of hot water, but not too much should be applied. After the leather is glued to the wheel it is the custom in Europe to fasten it with soft wooden pegs, about $\frac{1}{8}$ inch in diameter, driven through the leather into the wood and cut off slightly below the surface of the leather.

SOME RECENT RADIOMETRIC EXPERIMENTS IN GERMANY.

SINCE the radiometer was described by Mr. Crookes, it has been the subject of a large amount of observation, both in this country and on the Continent. We propose here to give a short account of two series of experiments lately made with it in Germany, where it generally passes under the name of the "Lichtmühle," or light mill. They appear to give some useful aid towards comprehension of the action of this somewhat enigmatical apparatus. The radiometers used were of the kind constructed by Geissler, of Bonn. They are wheel-shaped, the wings consisting of small leaves, apparently of annealed mica, blackened on one side with lamp-black; they are connected by platinum wires with a small cap, which turns on a fine needle point. The mill is enclosed in a vessel of thin glass, in which the air has been rarefied as much as possible. One series of experiments is that by M. Wartmann, described in the *Archives des Sciences* for March; the second by M. Weinhold, in *Carl's Repertorium für Experimental Physics* (Bd. xii., p. 105).

M. Wartmann had two radiometers, the one, A, with square, the other, B, with round wings. If both are exposed to the action of flame, or a glowing metal, or dark heat from an intense source of heat, they rotate with more or less rapidity, and the black surface is repelled. This may be called the "direct" rotation. The same occurs when the rays fall only on the black surfaces of the wings. On the other hand, there is a distinct difference between A and B, when the black surfaces are covered and the others exposed to the sun. While A shows a slow, direct rotation, B shows a distinct reverse rotation. In order to obtain this reverse rotation with A, the sunlight must be concentrated with a lens, and made to fall on the uncovered surfaces, while the blackened sur-

faces are very carefully protected against any radiation. If a less energetic source be made to act on B—namely, a glowing platinum spiral or a moderator lamp—then, without a lens, the reverse rotation is obtained slow and discontinuous; but it can be obtained easily, if two sources are used, acting in opposite direction on the uncoated surfaces, at the two ends of a diameter. If the source be removed, or its energy diminished, the motion of the mill takes place in a jerking manner. The velocity is greatest if the plane of the wing stands at right angles to the line of shortest distance from the source of radiation, the velocity diminishes with increasing obliquity of the repelled wing, then it becomes greater at the moment that the following wing receives the heat rays at a right angle.

On the two opposite surfaces of the same wing of B are concentrated by similar lenses the rays from two moderator lamps of the same calibre. By changing the distance of the lamps, one may succeed in entirely neutralizing their opposite actions. The action exerted on the black surface is then 11.9 times weaker than that on the white surface, "whence it follows, that to obtain equilibrium the intensity of the pressure must be in inverse ratio of the power of absorption. The least change of the distance, or the energy of the lamps, renews the motion." In a horizontal plane, and concentric with the radiometer, was placed an iron ring which had been raised to a red heat. Forthwith the rotation began, and it became very strong if the plane of the ring coincided with that of the arms. At equal distances above and below from this plane the velocity is the same. The radiometers were placed in a blackened case, which was perforated with an opening above. By means of a mirror a thin bundle of sun rays was reflected vertically and parallel to the plane of the wings. There always occurred a direct motion, whether the light was directed before the white or before the black surface; in the latter case the motion appeared to be quicker. If a moderator lamp be used instead of sunlight, the rays must be concentrated with a lens. The interposition of a very transparent plate of alum weakens to a great degree the action of a good lamp on A and on B. The two radiometers are unresponsive to the largest sparks of a Ruhmkorff coil or a Holz machine, but the wings are distinctly attracted on approximation of an electrified body. In the magnetic field of a large electro-magnet, the mills show the ordinary actions of induction. In water of 12 deg. within a cylindrical glass vessel A behaved as in air, but its rotation was under these conditions slower. The radiometer B, on the other hand, showed the reverse rotation when the rays of a strong moderator lamp were concentrated with a lens on an uncoated wing. If the water in which the instruments are heated to 60 deg., they remain motionless. When the radiometers are placed over a stream of heat, for example, an alcohol lamp with flame, the rest or motion of the mills is no way affected. When, however, the rising stream of hot air has raised the temperature of A to melting of the shellac on the point of the apparatus, the mill moves a little with frequent intermittence, and at length shows a slow, direct rotation. This suddenly ceases if the source of heat be removed, and it is slowly reversed during the first phases of cooling.

"The difference," M. Wartmann observes, "in behavior of the two radiometers, could not arise from the unequal surface of their wings. It appears to me rather that in the interior of B the rarefaction of air had not been carried so far as in A. Further, the white surfaces of B have a higher polish and brightness than those of A, their power of reflection must therefore be greater. These various experiments appear to confirm the view which attributes the movements of the mills to the expansions of the gaseous bodies under very weak pressure." The experiments made by M. Weinhold had the direct object of testing the different explanations that have been offered of the phenomenon. He, therefore, made a number of changes in the radiometers, some of which we shall notice. He first convinced himself that different specimens of the instrument are sensitive in quite different degrees to radiation of varying strength; and, therefore, that the wheel-shaped radiometer is not directly reliable as a measuring instrument for the strength of the radiation. M. Weinhold obtained radiometers which ran backwards on the radiation being cut off by using transparent mica leaves instead of the annealed and untransparent ones. If such an instrument be exposed a few seconds to strong radiation from a gas flame, and the flame be then removed, the mill first comes to rest and then begins to make a number of rotations in the opposite direction. This backward motion, however, is not due to action of backward radiation through the mica; for on interposition between the four wings of four new unblackened wings, consisting, in one case, of transparent mica, and in the second of annealed mica, the backward motion occurred in both cases. It is more probable that the backward motion is simply a consequence of radiation of the blackened surfaces, but that it only occurs when the wings have sufficient capacity for heat and conducting power. Indeed, radiometers with wings of magnesium metal show the backward motion in a remarkable manner. Some further modifications of the radiometer by inclination of the wings to the horizon, and by alternate use of blackened and unblackened annealed and transparent mica-leaves—for particulars of which we must refer to the original—convinced M. Weinhold that the motion is neither due to currents of minute quantities of gaseous matter, nor to the impellent force of evaporating water. It is rather, he thinks, due to some action—yet to be elucidated by experiment—of rays absorbed by the surfaces, and is in proportion to the amount of this absorption.

MANGANESE BRONZE.

AT the Woolwich gun factories, in England, experiments in the formation of a new alloy composed of copper, zinc, and manganese, are attracting much attention. The new metal is formed by the addition of from 1 to 2 per cent of manganese to the proper proportions of copper and zinc for the making of either bronze or brass. The alloy is said to be stronger than iron, and can be forged, rolled, and readily manipulated at a red heat. It is recommended for the sheathing of vessels instead of copper; and it is said to be better adapted for the armoring of war vessels than either iron or steel, since it is both lighter and less easily penetrated by shot. Its cost is about the same as that of brass. The experiments which have been made in charge of Col. Younghusband, seem also to demonstrate that the new metal will go into use for the construction of guns.

THE ST. GOTHARD TUNNEL.

AT the close of April, the St. Gothard Tunnel had been pierced on the Goeschenen side to the extent of 10,263 feet. The corresponding progress effected at the same date on the Airolo side was 9830 feet. The aggregate distance pierced April 30th, 1876, was thus three miles 4253 feet.