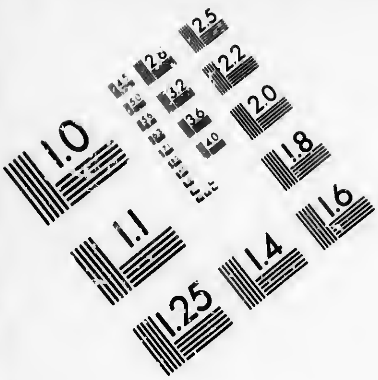

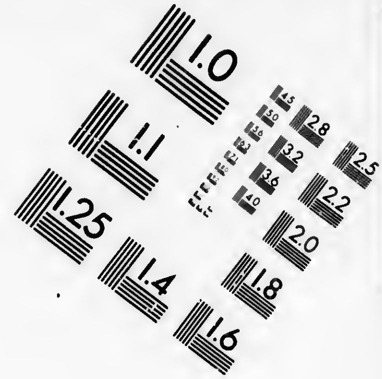

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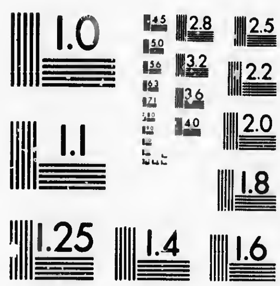

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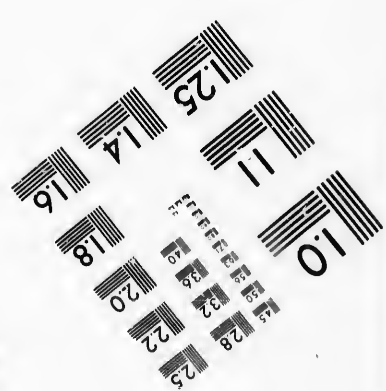

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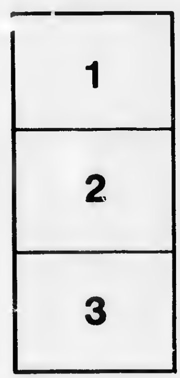

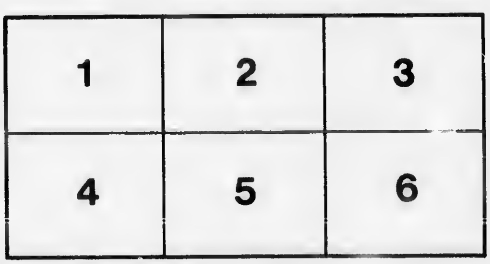

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Canadian Society of Civil Engineers.

ESTABLISHED 1887.

To be read May 26 or June 9.

TRANSACTIONS.

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THE WARMING, VENTILATING AND LIGHTING OF RAILWAY CARS.

A more unsatisfactory question than that of railway car heating and ventilation it would be difficult to find. Not only do car designers disagree, but the passengers have ideas and wishes so diametrically opposite, that a satisfactory solution does not at present seem possible. Do not expect it from the author, who will esteem himself happy if he succeeds in conveying a fairly clear idea of the problem, and of those recent attempts at its solution approaching nearest to success.

The problem, considering the wide and rapid variations of a North American climate, is certainly a double one, although experience and the Patent Office records show that each factor is usually attacked singly; and at first we had perhaps better so look at the subject.

The requisites of a good heater are:—

(*a*) That it give out heat sufficient in amount.

(*b*) That it be safe from fire risk, scalding, &c.

(*c*) That it be frost proof.

(*d*) That it be controllable without too much attention.

(*e*) That if it be part of a continuous system, it may be detachable without rendering it useless, and that it have a variability of from two to fifteen cars.

(*f*) That its heat be distributed equally throughout the car, and close to floor.

Ordinary stoves are wanting only in *b* and *f*, and Spears encloses his hot-air stove in a close-woven, heavy wire netting, slightly elastic, yet strong enough to fill requisite *b*; stoves manufactured from wrought-iron, instead of thin, cheap cast iron, having common-sense doors, and located in centre of length of car, come very near to satisfying all requirements.

Steam heating—at low pressure—with the heat supply located in a portion of the train not occupied by passengers, fills all requisites except *c* and *e*, the more recent inventions being endeavours to meet steam pipe to atmosphere at end of last car only, the excess of water in hot well under each car being intermittently discharged by self-acting trap.

The continuous circulation and its control, when car is detached and fire is put under hot well, cannot be said to be perfect with either system, Emerson having to use a second series of pipes on car roof to act as a condenser or cooler, and the Sewall slowly loses its water supply, due to the permitted escape of steam, through a pin hole at end of the continuous pipe.

The pounds of steam condensed to water per car per hour are variously given, the independent tests (far too limited in number) showing higher figures than those given by the patentees. The C., M. & St. P. Railway obtained an average of 75 lbs. at temperatures between 20° and 40° above zero. However, their careful experiments will not permit even an approximation of the weight of steam required with high winds and temperatures from 20° to 30° below zero. It may be deduced from some experiments with these systems, and a locomotive with a boiler so large that it is not ordinarily worked up to its maximum capacity, that 1 lb. of soft coal burnt in its fire-box will radiate an amount of heat equal to 2 lbs. of anthracite burnt in the car; therefore, after allowing a margin for fuel used when car is detached from locomotive, the total or annual cost for fuel, when the rolling stock is fully equipped, will be but one-half that now paid for hard coal, ranging at present on various railways from $35 to $55 per year per car.

We have not as yet, and cannot get until next winter, any information upon the continued action of "traps" in getting rid of lo l condensation at extremely low temperature.

Hot water heaters—that is to say the contained coil and vertical boilers of Owen, Baker, Smith, Johnson, Coughlan, Salmon, etc.—fill all requirements, except "B" and "C," and various schemes have been tried and suggested to overcome these defects, such as enclosing the whole in a metal safe with self-shutting doors, or making the water-crown of stove boiler of thin cast-iron, so that it shall in case of accident instantly fracture, thus drowning the fire, or arranging that derailment open a reservoir of chemicals which shall discharge into and kill the fire. The dead weight of the safe and its contained stone would be dangerous in time of collision; self-quenching arrangements cannot be depended upon if left disused, say for 12 months; and it is possible that the escaping vapors might prove as dangerous to life as would hot cinders.

Exhaust steam from the locomotive cylinder and from the brake air-pump have been slightly experimented with as a source of car heating; but the water carried in suspension is so large in amount and so difficult to get rid of, as to discourage any hope of success in that direction, in Canada at least.

Stoves underneath the car frame have been used; but the supply of heat—with hot air system—is not always adequate, and the gases of and the more this amount can be increased without inducing draughts the better.

For summer service a narrowing opening at front end of car under platform hood will no doubt admit enough air when car is moving; but it is not sufficiently diffused, a draught being felt about the 4th or 5th row of seats, which fine wire screens or adjustable louvre boards fail to get rid of. A roof cowl, of almost any pattern, open to front of train, will force sufficient air in, and it can be distributed at various points in ceiling, sides or floor, according to the number of distributing pipes and adjustable registers used, but the air there collected is far from pure, the dust not only annoying the passengers, but part of it settles in the pipes, eventually choking up the passages. Fine wire screens reduce the air pressure out of all proportion to the dust they exclude, and have no effect on smoke, sulphur, etc., from engine, which is apt to trail over the train, especially in woody country and in cuttings. Thirty-two years ago air was so forced through water-spray, the resultant inky color of the water proving that it performed its work well; but the apparatus occupied too much space, and in damp weather the car was too moist for comfort. Ruttan of Cobourg passed the air over water, this proved not so effective, but the car was dryer, yet his system collected so many impurities in the purposely contracted passages, that it was not used with success on long trips. A double roof with the open space between, bell-mouthed at each end, and the lower roof perforated, will act as efficiently as a distributing flue in securing full admission of air (and a double roof insures a cool ceiling), but it is no nearer to securing clean air. A fan, worked from car axle, drawing its air supply through gauze-covered opening in the *side* of car, passing it over an ice box, distributing it around top of car from a 6 in. tube and exhausting through the floor, has worked well when the car was running at full speed; but when going slow or climbing grades it did not give sufficient supply, and passengers were provoked to break windows that (necessarily in this as in all artificial systems) had been fastened down. It should not be forgotten that all similar schemes result in a car being oppressively close when it is not in motion.

There are several patents for taking air in front of the engine, warming or cooling it there as required, an independent steam motor forcing it to each car through a continuous train pipe. The bulk size of the apparatus involved will probably discourage experiment in this direction until all other possible expedients have failed.

For purifying the air we know of no scheme equalling that of W. D. Mann, who says, "taking my cue from nature's provision in the human nose......I have adopted a 'nose' through which all air is obliged to pass. This consists of a mass of 'excelsior' (fine wood shavings like hair), held loosely by spindles of wire, and kept moist by the melting of ice over it......the air being first discharged directly on the surface of a large pan of water, the product of the melting ice." This is one of the luxuries of travel paid for when you occupy a Mann Boudoir Car!

LIGHTING.

ing motion from an independent engine is costly, and requires the constant attendance of a skilled man, and is useless when detached from the train; hence the attempt of Messrs. Houghton & Stroudley, who combined a secondary battery with a dynamo driven from a car axle, their action alternating, or even if required supplementing each other, the mechanical details being so arranged that the batteries could not play back into the dynamo when it was running at slow speed, also the axle could revolve in either direction without interfering with the efficiency of the combined apparatus, the whole of which was carried in the guard's van.

The system of electric car lighting, of which we have most exact information, is the Julien secondary battery; it has much less dead weight than the Plante Faure and other early patents, and it can be charged from any electric source. Its standard cell has 19 plates and weighs 27 lbs., or with rubber box and connections 34 lbs. To find the total weight required per car, divide the wished for candle-power of the lamp by 2, which will give the weight of battery per lamp-hour. Thus 16 c. p. lamps require 8 lbs. of battery, and 10 lamps 80 lbs., or per night of 10 hours 800 lbs. Allowing 20 per cent. for contingencies the ten 16 c. p. lamps for one night's duty call for 960 lbs. weight of cells, or with connections 1,200 lbs. per car extra weight to be hauled (as a minimum).

The cost, as submitted by the Julien Co. in their recent offer to the N. Y. C. Ry. Co., and actually charged to the Wagner Car Co. for equipping the "Olga," is

60 cells at $13	$780
Wiring, boxes, and lamp fixtures	150
Total cost	$930

The daily cost, using the figures obtained from the B. and A. Railway, is

60 cells at $13 = $780, depreciation at 30 p.c. =	$234	00
24 lamps at 85c. = $20.40, each lamp lasting 2 months, 6 renewals at $20.40 =	122	40
Charging battery 365 days at 75c. =	273	75
Interest on $9.30 at 4 p.c. (cost of installation) =	37	20
Total cost of 24 lamps per year	$667	35
Cost of 24 lamps one day	1	83
Cost of one lamp per day	7	63

The batteries will probably last longer than 3 years, although actual experience with them covers little more than 2½ years; the negative plates never give out, and the positive plates have not yet done so, whatever the violent motion inseparable from railway travel may yet result in.

The weight of this installation will exceed one ton, and should the exigencies of train working require that a second set of cells be kept for charging, while the other set are in use, the cost for a car as fully lighted as the "Olga" would exceed $1,700.

To sum up:—it may be said, that if boiler-power can be supplied, there are no great difficulties under average conditions in heating a from two to fifteen cars.

(*f*) That its heat be distributed equally throughout the car, and close to floor.

Ordinary stoves are wanting only in *b* and *f*, and Spears encloses his hot-air stove in a close-woven, heavy wire netting, slightly elastic, yet strong enough to fill requisite *b*; stoves manufactured from wrought-iron, instead of thin, cheap cast iron, having common-sense doors, and located in centre of length of car, come very near to satisfying all requirements.

Steam heating—at low pressure—with the heat supply located in a portion of the train not occupied by passengers, fills all requisites except *c* and *e*, the more recent inventions being endeavours to meet these particular requirements.

The Martin system receives its steam supply from the locomotive. It has, for distribution, one through or continuous train pipe under each car, with a metallic double-ball coupling and expansion sleeve for connection at each end, and a double vertical line of piping for heating purposes on each side of car below seat level, having, however, no provision for keeping car warm when it is not attached to locomotive or coupled up to station steam warming pipes or to external portable boiler. Similar crude attempts at steam warming have been made ever since Stephenson's day. The metallic flexible coupling for the through pipe appears to be its distinctive feature; but it is open to doubt if a claim for originality could be sustained if this patent were subjected to legal test.

The cost of equipping is $200 for engine, $200 for ordinary cars, and $250 for sleeper and parlour cars.

The Sewall and Emerson systems appear at many points to be identical. They draw their steam supply from the locomotive, and use a hot well under the car to receive the water of condensation, below which a fire is placed when the car is standing detached, the car heating pipes being arranged so as to give independent circuit with this reservoir boiler. The auxiliary source of heat—be it coal fire, oil lamp or gas jet (and all have been used)—is dumped or otherwise dispensed with as soon as car is to be coupled up with train, thus meeting requisite *b*.

Many-ply rubber hose is used to allow of adjustability in the continuous couplings. The expense of renewing each hose may amount to $3 or $4 per year. Sewall has a simple and effective metallic hose coupling, locking by gravity, and readily separating when cars become detached, which will permit of a free interchange of cars with foreign railways on through runs. Emerson has apparently not given this most important point any special attention, and each car with his equipment having an independent outlet by pit-cock for the excess of steam and water, it causes, with this arrangement, a vapour to rise, sometimes obscuring the windows, and the annoyance of a constant drip of water has been noticed. Sewall has a small opening in through would be dangerous in time of collision, self-quenching arrangements cannot be depended upon if left disused, say for 12 months; and it is possible that the escaping vapors might prove as dangerous to life as would hot cinders.

Exhaust steam from the locomotive cylinder and from the brake air-pump have been slightly experimented with as a source of car heating; but the water carried in suspension is so large in amount and so difficult to get rid of, as to discourage any hope of success in that direction, in Canada at least.

Stoves underneath the car frame have been used; but the supply of heat—with hot air system—is not always adequate, and the gases of combustion are liable to get into the hot-air flues. With these defects and a first cost about double that of a similarly equipped car, with internal stove, the risk from fire is not removed, and cars so fitted have in accidents been destroyed by fire. External heaters for hot water or steam are more effective, but the fire risk is not removed—it is only in part lessened.

The Gold system is practically a storage rather than a continuous system and has been used only on suburban railways (900 cars). A $3\frac{1}{2}$ in. wrought iron tube is almost filled with brine (water and salt), then ~~sealed up and~~ laid horizontally within a 4 in. steam pipe, so that when steam is admitted into the annulus between the two tubes, it not only radiates externally but heats up the contained brine, thus charging a reservoir, which when steam is cut off continues the radiation by parting slowly with its rapidly absorbed heat, so that for instance—with an external temperature just at freezing, a street car will retain a comfortable warmth for 2 hours. To suit ordinary train service it is proposed that the reservoirs shall be charged when the locomotive is running down grade and it has steam to spare. The defects of this system are a difficulty in obtaining flexible couplings for high pressure steam, and the risk of scalding in case of accident; and the fact that failure of locomotive would eventually result in freezing out the passengers, prevents it being considered a pratical scheme for long through runs or isolated branch trains.

VENTILATION.

Having continuous steam-pipes throughout the car, the question of ventilation in winter is not a difficult one, a few small inlets close to pipe, with wide, open, exhaust ventilators in roof giving free exit, are conditions fairly conducive to health and comfort.

The many and variously designed stoves, with passages in or around them, through which air is forced from Cowl or Bell mouth on top of roof when train is in motion, and thence through hot air flues provided with foot registers the length of the car, have not proved a success, being deficient in heat, at the same time making the air too dry. Heat radiated is far more comfortable and healthy than heat delivered by convection.

The minimum supply of fresh air required to keep a car carrying 60 passengers in sweet and healthy condition is 1,000 cubic ft. per minute, until all other possible expedients have failed.

For purifying the air we know of no scheme equalling that of W. D. Mann, who says, "taking my cue from nature's provision in the human nose......I have adopted a 'nose' through which all air is obliged to pass. This consists of a mass of 'excelsior' (fine wood shavings like hair), held loosely by spindles of wire, and kept moist by the melting of ice over it......the air being first discharged directly on the surface of a large pan of water, the product of the melting ice." This is one of the luxuries of travel paid for when you occupy a Mann Boudoir Car!

LIGHTING.

The existing sources of artificial light are candles, oil, gas (coal, oil, water), and electricity. Candles are wanting in brilliancy, cleanliness and safety; and are not now used. Oil has been roundly abused in the public press and in some State Legislatures, nevertheless mineral oil of 300° fire test is, we think, all things considered, a safe source of light—absolutely so if there be no other source of fire in the car than the lighted lamp itself. Certainly there are but few, if any, cars destroyed by fire in summer, when the increased train service partially balances the fewer hours per night that lamps have to burn, and if steam warming be adopted all trains would, in winter, be as safe from fire risk as they now are in summer.

Coal-gas carried within wrought iron reservoirs, under a pressure of about 230 lbs. per sq. in., gives a brilliant light, and a reservoir 10 ft. long by 1 ft. diameter will hold sufficient gas to run a 5 ft. burner 50 hours, or the car for 10 hours. The first cost of fixed plant for compressing and storing coal-gas is heavy, varying from $2,300 to $18,000 per station (not including cost of gas producers), and there is a large daily expense in running the plant in addition to a serious loss of gas, when it is under compression, due to its condensing into a troublesome gummy liquid, which interferes with the action of all the mechanical fittings and the self-acting pressure reducing valve, as well as with the efficiency of the small distributing pipes.

The Pintsch system gets rid of some of these troubles by using gas manufactured from crude petroleum, or other natural hydro-carbon, which, in addition to being less sensitive to low temperatures, to loss by compression, and to gummy condensation, gives a clearer white light of higher illuminating power; the economy resulting from the use of this system compared with that of coal-gas is marked; it having but one drawback, viz., each charging station must be equipped with a complete gas *distilling*, as well as compressing apparatus, otherwise, special gas storage tanks on wheels must be regularly transported to the distributing points, from the central manufacturing and compressing depot. English experiments show that colza oil costs per lamp per hour $1.25 cents, and the Pintsch light only ·652 cents.

In electric lighting there have been experiments with primary batteries, secondary (or storage) batteries, independent dynamo, and dynamo taking its power from a revolving car axle. A dynamo deriv-

The batteries will probably last longer than 5 years, although actual experience with them covers little more than $2\frac{1}{2}$ years; the negative plates never give out, and the positive plates have not yet done so, whatever the violent motion inseparable from railway travel may yet result in.

The weight of this installation will exceed one ton, and should the exigencies of train working require that a second set of cells be kept for charging, while the other set are in use, the cost for a car as fully lighted as the "Olga" would exceed $1,700.

To sum up:—it may be said, that if boiler-power can be supplied, there are no great difficulties under average conditions in heating a train by steam supplied from the locomotive. Boiler power in midwinter on any other than short local runs is, however, rarely in excess of absolute needs, and if boilers large enough are built the locomotive will be so much heavier so to probably call for the strengthening of bridges, &c. If compressed gas be used for lighting, it can readily be adapted as a source of heat with any system of circulating steam pipes.

Ventilation, in winter when steam pipes are used, taking air supply through sides of car close to pipes, and keeping exhausts open in raised roof, is easily accomplished. In summer it is different, and some artificial means for supplying, cleansing, and distributing a large amount of air is necessary, and such schemes will not work if passengers have the option of opening side windows, thus destroying the artificial currents. There are strong objections to machinery, as it must not be recognized as such by the passengers, be too expensive, require too much attention, or be liable to derangement.

Induced current, by air, jet worked from the brake, reservoir, may yet accomplish this work satisfactorily.

If each passenger is to be allowed to do what is right in his own eyes, it is probable that side windows hung so as to swing vertically, instead of lift horizontally, would keep out more of the cinders, etc.

For lighting, oil or oil gas are safe enough, and ignoring the question of interest on the heavy first cost of the equipment, the actual daily outlay for gas would probably be less than for oil (taking all breakages of lamps, etc., into consideration).

Electric lighting—cool, safe, and pure—is as yet somewhat uncertain in effect, too expensive in first cost, or it calls for too highly paid skill in attendance, to be generally adopted.

Not only for economy in the use of light, but also for cheerful effect in daytime, the internal "finish" of cars should be in light coloured woods, and also with the object of lessening fire risks the "finish" should be, where possible, in wood rather than in woven fabrics.

Cars wholly framed in metal, whatever be their relation to fire risks, are not likely to be a success for passenger service, because of the difficulty in deadening the annoying vibrations and noise incident to motion.

J. DAVIS BARNETT.

8th April, 1887.