MEASURING THE MECHANICAL EQUIVALENT OF HEAT.

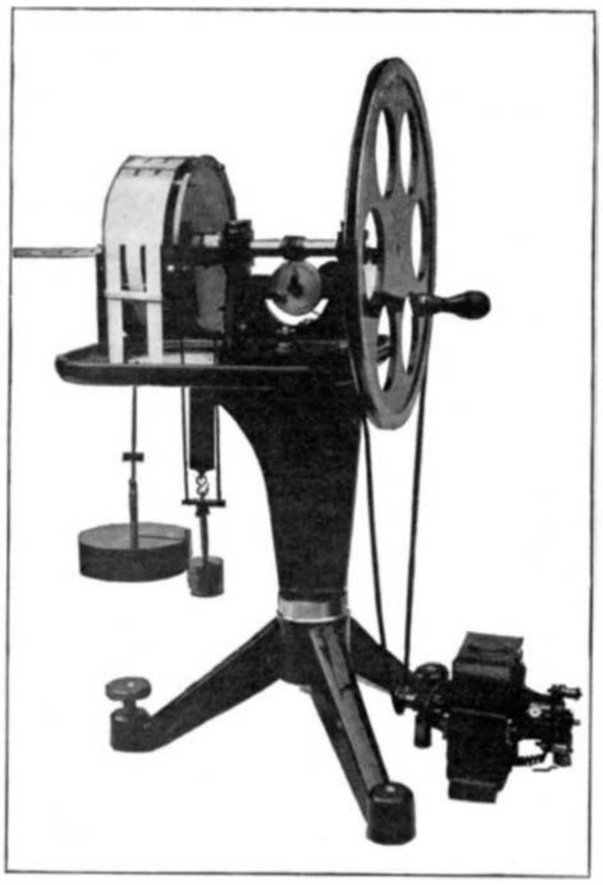
BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

A new apparatus for measuring the mechanical equivalent of heat was recently described before the Physical Society of Great Britain. It is the invention of Prof. H. L. Callendar, F.R.S., who devised the Callendar electrical thermometers, and is manufactured by the Cambridge Instrument Company, of Cambridge, England. The apparatus comprises a cylindrical calorimeter of thin brass, the axis of which is horizontal, and which contains a previously determined quantity of water. This calorimeter is rotated at a moderate speed either by hand or by means of a water or electric motor. From the ends of a silk belt slung over the cylinder unequal weights are suspended and arranged so as to make one and a half complete turns round the cylinder. A light spring balance is attached in order to insure stability of equilibrium and this acts in direct opposition to the lighter weight. As this spring balance contributes only a small (positive) term to the effective difference of load at the two ends of the belt the small errors in its readings which focus are relatively unimportant. The extreme flexibility of the belt insures that to a very high degree of approximation the difference of load at two ends is the true measure of the friction. The weights are adjusted by trial to suit approximately the friction of the belt, the final adjustment being effected automatically by the spring balance. A counter registers the number of turns which have been given to the calorimeter, while the rise of temperature is read by means of a bent mercurial or platinum thermometer, inserted through a central opening in the front end of the cylinder. The external loss of heat is either eliminated by Rumford's compensation method, or by carrying out two experiments with different loads on the belt. The motion of the surface of the calorimeter eliminates the effect of drafts and convection currents, so that the loss of heat is much more regular than if the surface were at rest.

The stand of the apparatus may be screwed to the table or to a wooden board with heavy weights upon it. The silk belt is wrapped round the calorimeter so as to encircle it one and a half times; three-quarters of the circumference of the calorimeter is then overlaid by the single part of the belt and a like amount by the double part of the belt. The single part of the belt is at the same side as the spring balance and thereto is attached the stem for carrying the lighter weights. By means of a leveling screw the axis of rotation of the calorimeter can be rendered approximately horizontal. When the apparatus is utilized for lecturing purposes, the calorimeter may be driven by means of a ¼-inch round leather belt from a small water or electric motor. In order to obtain success in operation the revolving velocity of the calorimeter should be from 60 to 120 turns per minute. With 4 kilogrammes on the double side of the silk belt, the rise of temperature approximates 1 deg. C. per 100 revolutions. The simplest method in which to carry out an experiment is to deliver about 350 grammes of water at 10 deg. C. from the pipette into the calorimeter by means of the small rubber tube and brass nozzle which fits into a screw hole near the rim. The motor is then set in motion at a suitable speed and readings of the temperature taken every 100 revolutions. It is necessary to observe the mean temperature of the surrounding air near the calorimeter during the experiment, then select from the observations a range of 500 or 600 revolutions during which the mean temperature of the calorimeter is nearly the same as that of the air. The correction for external radiation will then be practically negligible.

After starting the calorimeter the weight on the spring balance side should be adjusted so that the 4-kilogramme weight is raised clear of the stops and held in floating equilibrium with the reading of the spring balance somewhere near the middle of its scale.

After 100 or 200 revolutions the friction will become practically constant. The silk belt must be kept clean or the friction will not be steady. The work is the product of the difference of the weights on the two sides, the heavy weight plus the spring balance reading minus the light weight by the number of revolutions and the circumference of the calorimeter, which is measured with a thin steel tape. The heat generated is the product of the total thermal capacity of the calorimeter, and its contents by the observed rise of temperature. The latter must be corrected for errors of the thermometer, and reduced to the scale of the air thermometer.



PROF. CALLENDAR'S APPARATUS FOR MEASURING THE MECHANICAL EQUIVALENT OF HEAT.

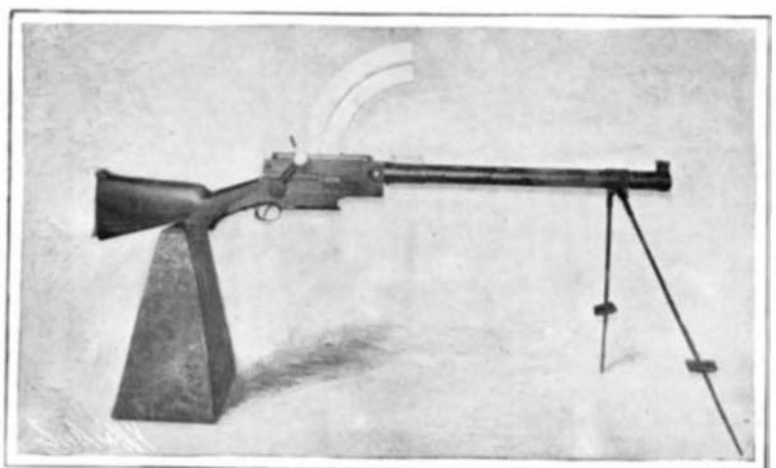
The apparatus is very simple both in its design and appliance and is of special value for demonstration and lecturing purposes. It is reliable in its operation because the friction is almost independent of the speed. The balance is automatic. Furthermore there is no change in thermal capacity of the calorimeter with change of speed or of load. No errors can occur, as there is no pulley or bearing friction. Lastly the factors of the mechanical work expended are ascertainable to a high degree of accuracy.

THE REXER AUTOMATIC MACHINE-GUN.

For a number of years we have been accustomed to consider that our modern rapid-fire and machine-guns were capable of little improvement, and that the weapons of this branch of naval and military artillery would remain practically unchanged for some time. As regards the rapidity of fire this belief appears to be correct, for there are certain physical reasons, such as the heating of the gun barrel, which tend to keep the rate of discharge within certain limits. But great advances have recently been made in the simplification of the mechanism and the reduction of weight of machine-guns in a Danish invention, now known to the public as the Rexer automatic machine-gun. It is claimed for this weapon that the fighting power of all branches of the army service will be greatly increased by reason of its lightness and portability, combined with its comparatively high rate of fire, while at the same time the transport requirements will be reduced. The gun has been adopted by the Danish government, and a number of others, including Japan, have reported favorably upon its performances.

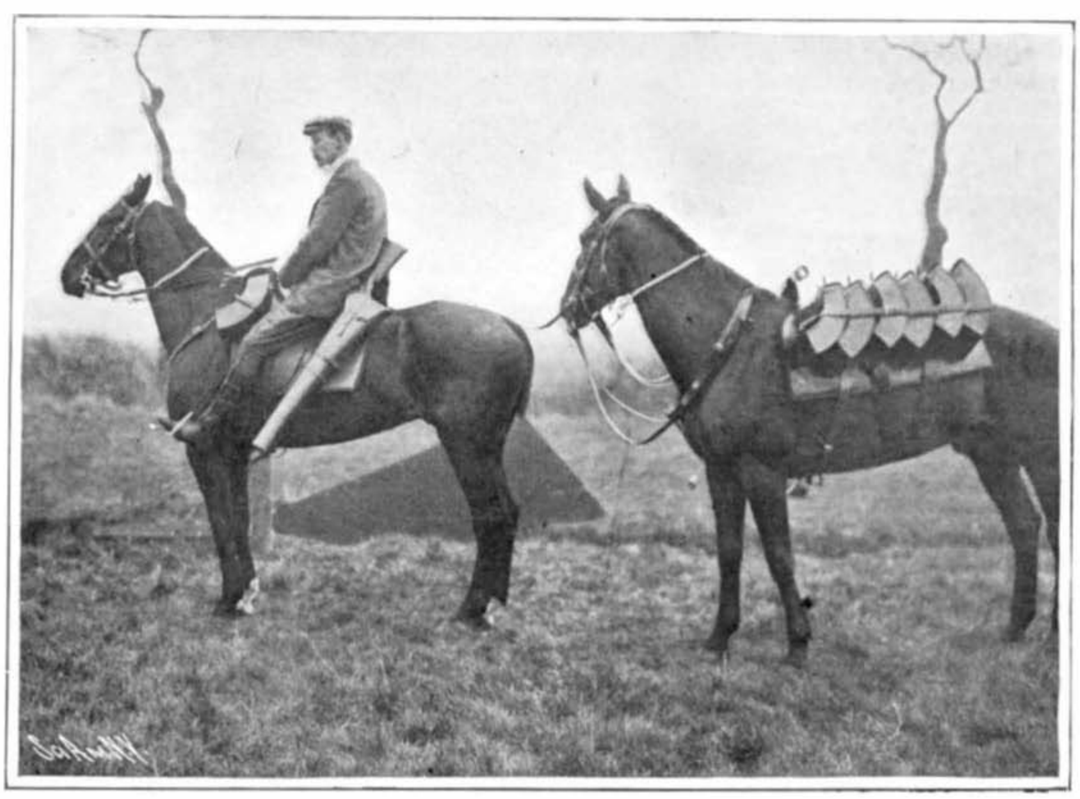
The Rexer machine-gun is really a shoulder-arm, and resembles a large rifle of the ordinary type. Its weight is about 17½ pounds, and while this is considerable in comparison with that of the common rifle, it is a vast decrease from the 60 pounds of other machine-guns. The operation of the weapon is very simple. The gunner lies flat on the ground with the stock pressed against his right shoulder. Two light legs, forming a support, are attached near the muzzle end of the outer casing and the special joints with which these are provided permit the weapon to be trained into any position and to be elevated or depressed within generous limits. When not in use the supports are folded back against the barrel. The cartridges, contained in curved clips or magazines in batches of twenty-five, are fed into the top of the breech casing by the left hand of the gunner. A single pull of the trigger, and the twenty-five cartridges in one clip are discharged in less than two seconds. A rate of 300 shots a minute can be maintained with little trouble, and as the supporting legs and a perforated casing surrounding the barrel proper obviate any handling of the same, the gunner is not troubled with the heating of the weapon. The position of the operator—flat on the ground—affords the greatest protection with minimum "cover;" and this, together with the inability of an enemy to distinguish the Rexer gun, even at short distances, from an ordinary rifle, gives this type of weapon a preponderating advantage over many other kinds of rapid-fire guns.

Fundamentally the Rexer gun depends upon the same basic device as nearly all other weapons of this type, as the power for working the mechanism is obtained from the recoil. The weapon comprises essentially the stock, the casing, and the trigger-plate, which inclose the breech mechanism, the



HOW THE REXER RIFLE IS FIRED.

HOW THE REXER RIFLE IS CARRIED.



THE REXER RIFLE AND ITS FIELD EQUIPMENT OF AMMUNITION.

rifled barrel, and a perforated barrel-casing or outer tube. The recoil drives the barrel with the breech and other moving parts some two inches backward within this outer tube, thus compressing a strong recoil spring which is inclosed within the front part of the stock. This, after the force of the recoil is spent, expands and drives the barrel forward again into the firing position, the recoil and return of the breech operating a mechanism within the casing which ejects the empty cartridge-case, inserts a new cartridge into the chamber, closes the breech, and fires the shot.

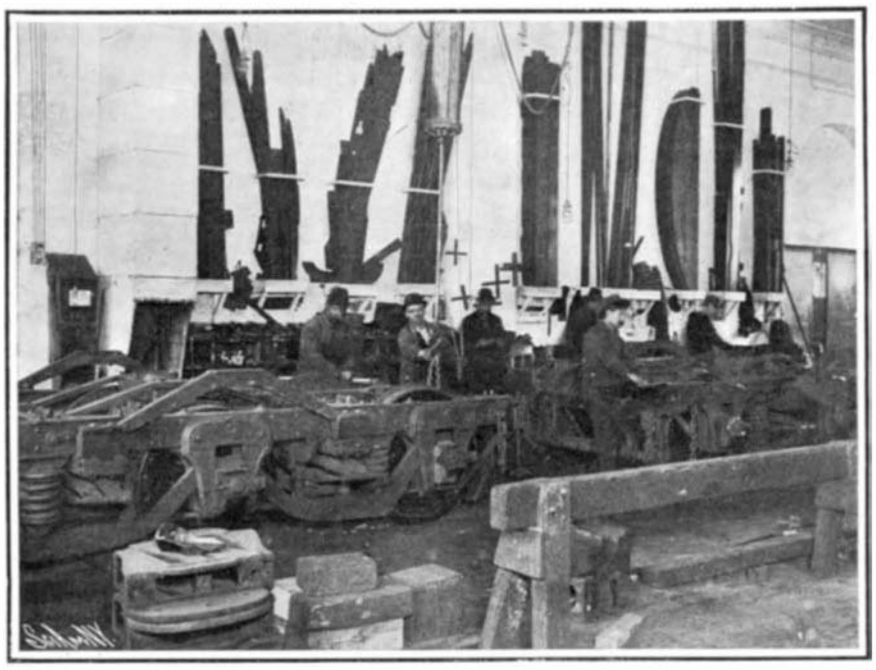
Among other advantages claimed for the Rexer machine-gun is its convertibility by a simple process into a single-shot rifle, by which it becomes available for deliberate shot-by-shot fire like an ordinary rifle or carbine. For the reasons given above, it is less liable to be put out of action than any other machine-gun, for its inconspicuous appearance will not attract undue or embarrassing attention from the enemy. By reason of its lightness and portability, it is easily carried on the march by cavalry or infantry. This fact is demonstrated by the illustrations, which show as well the ingenuity and practical simplicity of the equipment.

THE BUILDING OF A RAILWAY CAR.

BY DAY ALLEN WILLEY.

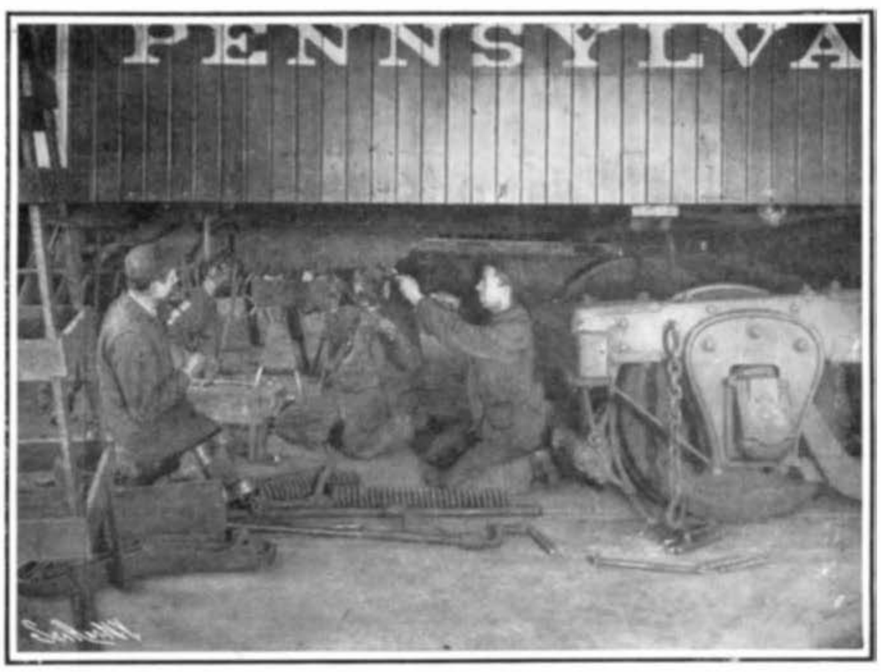
The passenger car as seen on the standard-gage American railroads of to-day represents the progress of over a half century which has been made in the construction of this type of rolling stock. Experts have given the United States credit for building not only the strongest but most comfortable and convenient passenger coaches in the world. Whether this tribute is deserved or not, there is no question that the so-called day coaches in service on the principal systems are much more substantially constructed and more luxuriously appointed than even ten years ago. In fact, some of them are nearly equal to the ordinary Pullman car in upholstery, decoration, and conveniences.

It has been the aim of the builders, especially in recent years, to design a car of a sufficiently strong framework to prevent telescoping in collisions and other forms of accident, since the driving of one car through another has been one of the principal causes of great loss of life. The coaches of to-day can withstand far greater impact than even a few years ago, but this is not strange when the plan of building them is studied. In most instances the car builder commences at the bottom and works upward. First, he lays down what might be called the backbone upon supports usually placed, for convenience, high enough to allow the trucks to be run under the car when completed. The backbone is generally composed of Georgia pine timbers extending the entire length of the body and 5 or 6 by 8

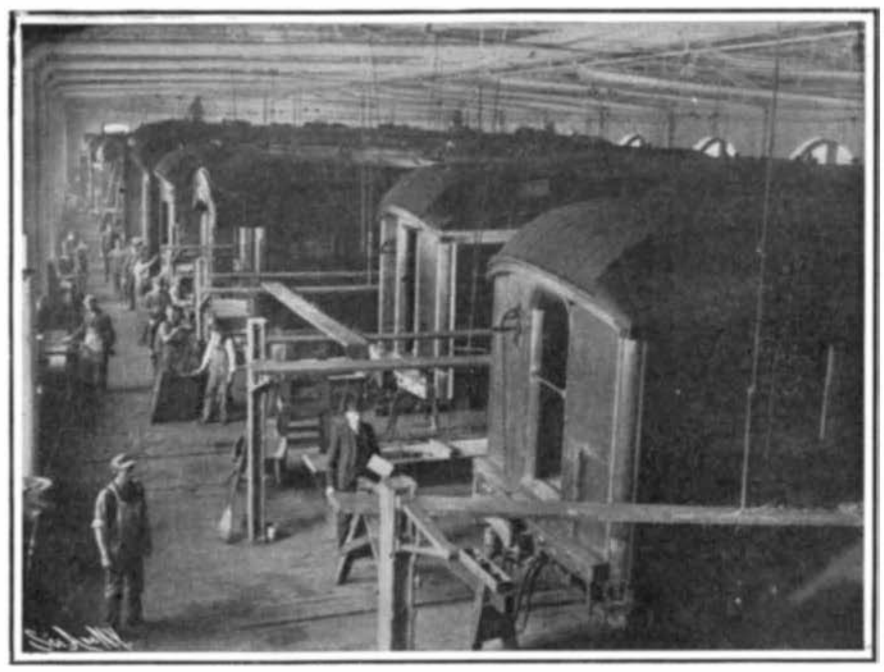


Assembling Car Trucks.

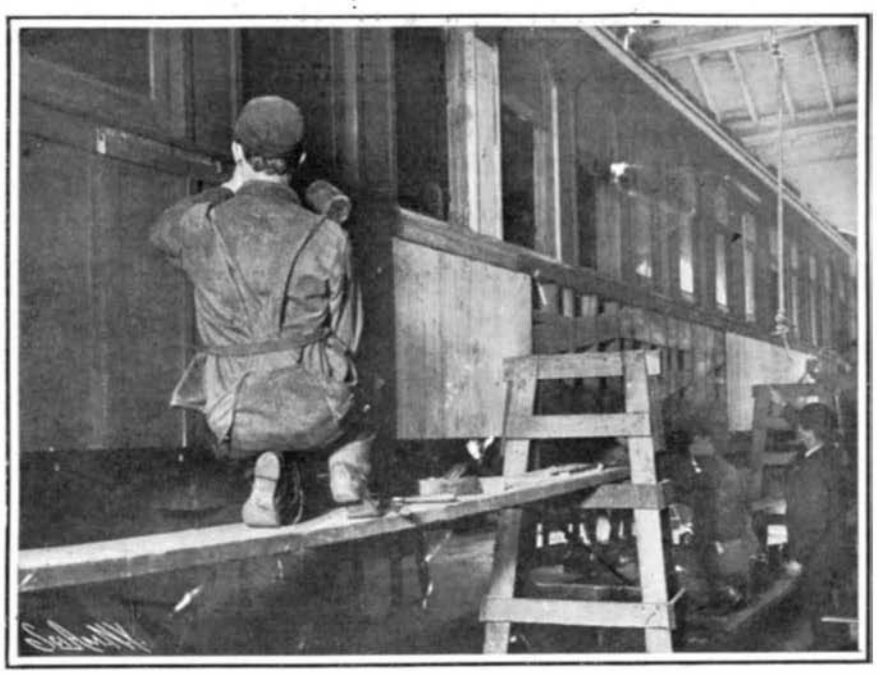
Fitting a Truck to a Freight Car.



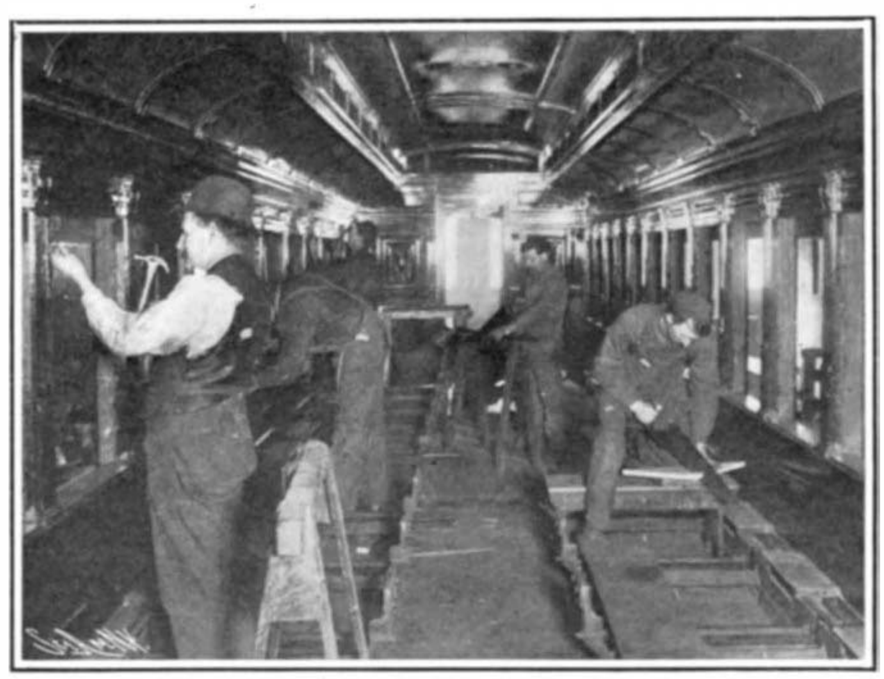
Fitting a Truck to a Completed Car Body.



In the Paint Shop.



Putting the Siding on a Skeleton Car Body and Hanging the Piping.



Nailing on the Hardwood Finishing.

THE BUILDING OF A RAILWAY CAR.