55½ acres per cubic foot per second. In later enterprises, it has been the effort to reduce it, to give at least 100 acres per cubic foot, and Mr. Maxwell, the State Engineer, is authority for the statement that the duty can be made 320 acres per cubic foot.

The great purpose of an irrigation enterprise is to endeavor to extend the service of the water to the maximum acreage, and in spite of the present low duty of water and the difficulties that have been met in the past few years in the great scarcity of supply, which ought to have been of great service to those willing to benefit by experience in an effort to increase it, it is not too much to hope that a gradual increase of duty will be speedily obtained.

Other questions relating to irrigation—such as sub-irrigation, damages accompanying irrigation and the legislation affecting the whole subject—cannot well be treated in a single paper. The necessity for proper legislation is very great, however, as the risk in enterprises of this kind is sufficiently great without further burden of unjust and oppressive laws, and the law should be put in such shape as to be readily understood by all concerned.

In Colorado, as in most other irrigation countries, the necessity of carrying on works of drainage and irrigation simultaneously is being impressed upon practical men more and more every year. Although it is a rare occurrence when these works are successfully conducted together, it is regrettable to note the large and yearly increasing area of low-lying lands going to waste, and which are, during the irrigation season, stagnant swamps, breeding disease. The frequency of typhoid fever and other epidemics in the fall of the year is doubtless due to this cause, so that, from a sanitary point of view at least, drainage must be speedily undertaken On the other hand, on this matter of drainage the necessity of providing for the storage of water for the lands drained must not be lost sight of. It has been the experience of countries where, during wet seasons, great efforts have been made to carry off the water by drainage, that, in dry seasons, crops have been seriously affected by the lack of proper provision for storage of water.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

CHEMISTRY APPLIED TO RAILROADS.

VIII. METHOD OF PURCHASING OILS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page 272.*)

For the sake of completeness in the discussion of lubricants and burning oils, this article will be devoted to the question of how oils are bought, and to a discussion of hot boxes and hot box and lubricating greases.

It was formerly the custom with lubricating and burning oils to buy by measure, and measure was also used in distributing the oils for use in the service. This practice has been largely abandoned, it having been found that weight is not only a much more expeditious way of getting at the results, but also a more accurate one. If oils are bought by measure, with no check on the shipment, the number of gallons being stamped on the barrels by the manufacturer or shipper, there is a very wide chance for practices which are hardly to be recommended. At one time on the Pennsylvania Railroad a number of shipments of oil from a certain party were weighed, and the barrels emptied and the tare taken. On checking up the weights it was found that the barrels were universally from one to two gallons short. Indeed there was enough difference in the amount of oil charged for and the actual amount received to enable the party to bid from half a cent to a cent lower per gallon than those who gave full quantity. In the large amount of oil used by the Pennsylvania Railroad, the loss due to this practice amounted in one month to as much as $250 on one kind of oil, and at one place where the oil is received. This led to a change in practice, and now all oils are bought by weight, which method gives a very quick and efficient way of checking up a shipment, as will be seen by studying the circulars given below. When this practice was inaugurated, a circular was distributed by the Purchasing Department, informing the manufacturers what would be required in future in regard to shipments. This circular is as follows:

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

Purchase of Oil by Weight.

From this date, all materials used as lubricants and burning oils will be purchased by weight, and quotations of prices and bills must be by the pound. In quoting prices, cents and hundredths should be used. A separate bill must be rendered for every shipment, however small, even though it be but a portion of the whole order, and the bill must be sent *as soon as possible* after the shipment is made.

Every package containing lubricants and burning oils must be plainly marked with the gross weight and the tare. This applies to oil tank cars as well as to barrels. Parties failing to mark both gross and tare on their packages must accept the Company's weights without question.

Whenever a shipment of any lubricant or burning oil is received at any point, it will be immediately weighed, and where practicable will be at once emptied, and the empty packages weighed. If not practicable to empty all the packages, 5 per cent. of the shipment will be emptied and the tares taken. The tares of the whole shipment will then be adjusted in accordance with the weight of the 5 per cent. If the net weight found from above data is less than the amount charged for in the bill by more than 1 per cent., a deduction will be made from the bill equal to the amount of the deficiency over 1 per cent. This 1 per cent. covers leakages in transit, and the amount which adheres to the barrels in emptying; also, possible slight differences in scales.

THEODORE N. ELY,
General Superintendent Motive Power.

Office of the General Superintendent Motive Power, Altoona, Pa., October 1, 1885.

It took a little time for those who were accustomed to think of the price of oil in gallons to learn to compare prices by the pound, but this difficulty soon disappeared. It will be observed that the circular calls for a bill for each shipment, although the whole order may not be filled. The object of this was to enable the adjustment mentioned at the latter part of the circular to be made as soon as possible after the shipment was received. This method described in the circular, so far as the manufacturers and shippers are concerned, has worked very satisfactorily, and we have yet to learn of any disputes and difficulties having arisen in regard to it.

The system of buying by weight would have been incomplete without the information necessary to enable the bills to be checked up accurately being in the hands of the men, and accordingly a circular was issued to the men, giving them all the necessary information on this point. Also, at the same time this circular was issued, it was decided to dispense the oil to the service in small amounts by weight—that is to say, each engineman received a certain amount of burning oil, cylinder lubricant, and engine oil for the trip; also other branches of the service, especially where hand lanterns are required, must have an oil supply. Before the circular below was issued, this had always been done in gallons or quarts, and when the change to giving out the oil by weight was proposed, it met with some op-

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, is on the Work of the Chemist on a Railroad; No. II, in the January number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION of special value in indicating the true character of the materials they must use and buy.

position from those in charge of the oil houses on the ground that it would take too long to weigh. A direct experiment on this point, however, proved that with an ordinary spring balance, the necessary supplies of oil could be given to 20 enginemen in about half the time by weight that it could by measure. The process is excessively simple. An engineman brings his can, containing possibly a little left over from the previous trip, and wants, we will say, five quarts of engine oil. To supply this by measure would necessitate using a gallon measure and a quart measure. To supply this by weight simply necessitates hanging the can on the spring balance, with a funnel in it, and noting the weight. Then add 9 lbs. and 5 ounces of oil, which would be indicated by simply adding that figure to the weight of the can and funnel, as it hung on the balance. In a very short time, as soon as the enginemen began to call for so many pounds of oil, the system of distributing by weight came into great favor, and has been followed with great success.

The following circular gives the information needed by the men in order to start such a system on a railroad :

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

Instructions in Regard to Weight of Lubricants and Burning Oils.

All materials for lubricants and burning oils will, on and after October 1 next, be purchased and used by weight, and all requisitions for any of these materials, for purchases to be made on or after that date, must call for so many pounds instead of so many gallons or barrels as heretofore. The following are approximately the weights per gallon of different kinds of oil :

Lard oil, tallow oil, neat's-foot oil, bone oil, colza oil, mustard-seed oil, rape-seed oil, paraffine oil, 500° fire-test oil, engine oil, and cylinder lubricant, 7½ lbs. per gallon.

Well oil and passenger car oil, 7.4 lbs. per gallon. Navy sperm oil, 7.2 lbs. per gallon. Signal oil, 7.1 lbs. per gallon ; 300° burning oil, 6.9 lbs. per gallon ; and 150° burning oil, 6.6 lbs. per gallon.

The number of gallons of oil needed having been decided upon, the weight which should be called for by requisition is found by multiplying the number of gallons by the proper weight given above.

All parties furnishing lubricants and burning oils are required to mark each package with both gross weight and tare, but it is not sufficient to simply take these figures off the barrels and compare them with the bills. Every shipment of every kind of lubricants and burning oils must, as soon as received, be carefully weighed. This applies to tallow and greases, as well as all the oils used for lubrication and burning, and must be done whether the oil is subsequently emptied or not.

Wherever possible all lubricants and burning oils must be emptied at once, and the empty packages carefully weighed. In emptying, care should be taken to get all the material out of the packages. With tallow and grease, and with lard oil in the winter, this is especially requisite, and it will probably be necessary to steam out the packages.

Wherever material is shipped to other shops in the original packages, or where it is impracticable to empty them all, at least 5 per cent. of each shipment must be emptied and the empty packages weighed, the tares for the remainder of the shipment being taken from the packages themselves. If the weights of the packages, which are emptied, correspond with the marked tares, no adjustment is necessary. If they do not correspond, the tares for the whole shipment must be adjusted in accordance with the tares of the 5 per cent. which were actually weighed.

The gross weights and tares having been obtained, the net weights will appear. If the sum of the net weights thus obtained is not over 1 per cent. less than the amount charged for in the bill, the Form C may be signed in the usual way. If the deficiency is more than 1 per cent. of the amount charged for in the bill, a statement of the deficiency, together with the Form C, unsigned, should be sent to the Superintendent of Motive Power for adjustment and correction.

THEODORE N. ELY,
General Superintendent Motive Power.

Office of the General Superintendent Motive Power, Altoona, Pa., September 12, 1885.

In regard to the above circular, the weights given for the different kinds of oil are sufficiently close to accuracy, so that no serious trouble occurs in adjusting. Moreover, the system of buying by weight eliminates all questions of capacity. The words "Form C," in the circular, are the technical words by which the duplicate bill which goes into the hands of the party receiving the material is known.

IX.—HOT BOX AND LUBRICATING GREASES.

Perhaps no subject connected with the operation of railroads causes more annoyance, not only to the public but also to the operating officers, than what are known popularly as "hot boxes." In reality it is the journal and bearing which get hot, and not the box which encloses them, and carries the waste and lubricant. Much delay of trains and annoyance in every way is occasioned by these failures of the journal and bearing to run cool, and many speculations have been indulged in as to what the cause of hot boxes, using the technical term, is, and what is the best cure. Probably not less than 50 or 60 different compounds to be used in treating hot boxes have been analyzed and examined in the Pennsylvania Railroad Laboratory during the last 15 years. These substances are known under the general name of hot-box greases, and are to be carefully distinguished from greases offered for lubrication. The lubricating greases are not supposed to be used as a cure for a hot box, but in place of oil as lubricant on certain high-speed trains. On the other hand, hot-box greases are used only when the journal and bearing get hot in service.

Upon the general question of using grease in place of oil as car lubricant, our opinion, based on a number of years' experience now, is that, all things considered, oil is far the best lubricant. It would take a careful analysis, however, of all the points involved in lubrication to make clear the basis on which this opinion rests, and it is possible later on, in this series of articles, the question of lubrication may be discussed in full. For the present it is sufficient for our purpose to say, that in all cases where the pressures do not exceed 350 lbs. per square inch of projected area on the journal, and where the speeds do not exceed 30 or 35 miles an hour average, oils are altogether the best lubricants, provided proper attention and care is given to the car boxes. On the other hand, where the pressures may reach 400 or 450 lbs. per square inch, and where the speeds run from 35 to 50 miles per hour, something a little more viscous seems to give rather better results, and consequently in modern practice, especially where high speeds are employed, there is a tendency toward the use of grease in place of oil. So far as the Pennsylvania Railroad goes, however, this tendency must be regarded as still in the experimental stage. We do not think there is anywhere in existence information which shows positively that under the same care less difficulty is experienced even with high-speed trains, which are lubricated by means of grease, than with the same trains lubricated by a good oil. However, as stated above, there is in the conditions affecting the success of the lubricant a plausible basis for the use of a little more viscous material, where high speeds and high pressures are involved, than where lower speeds and less pressures prevail, and consequently, as has already been stated, there seems to be a disposition toward the use of lubricating greases on certain trains.

The lubricating greases which we have examined have in almost every case contained more or less petroleum product as a large constituent, the petroleum product being hardened or made more viscous by the addition of tallow, lard oil, or neat's-foot oil, and in some cases by the use of some of the vegetable waxes, such as japan or carnauba wax. Also in an experimental way the petroleum products have been mixed with rosin somewhat as a means of getting a lubricant which would hold up the load a little better, and, owing to greater viscosity, have a trifle greater power of staying between the surfaces. The question of lubricating greases, however, is so unsettled that we would hardly be able to give a formula for a good lubricating grease.

Upon the question of hot-box greases there is much more information, but before we speak on this point, it might be well to devote a few words to the causes of hot boxes. Popularly among the men, the oil or lubricant used is supposed to be the cause of many of the hot boxes. Frequently the bearing metal is supposed to be at fault, sometimes the waste is blamed, and much more rarely lack of care, or lack of lubrication, or bad fitting of journal and bearing are blamed with the difficulty. To those who are not familiar with the method of lubricating car journals, it may perhaps be well to say that the bearing which holds the weight of the car rests on top of the journal, covering about three-quarters of its diameter; that surrounding both bearing and journal is the cast iron-box which rests on top of the bearing, and has considerable open space below the journal, which open space is filled with wool waste or mixed wool and cotton waste saturated with the lubricant. This box is made as close as possible behind, and fitted with what is known as a dust guard, which encloses the journal as tightly as possible on the back side. On the front side the box is opened by a lid, and the condition of the waste is examined at each inspection point, being stirred up if necessary, and fresh lubricant added. By this method of lubrication, as will be seen, the journal is dependent for the lubricant that it gets from the waste on touching the waste, and among the causes which are sometimes given for hot boxes is, "Waste too far from the journal."

Turning now to the cause of hot boxes, our own view, based on the experience and observation of a number of years, is that there may be a number of causes producing a hot box. With the lubricant in common use on freight cars, a pressure above 350 or 400 lbs. per square inch on the bearing is quite apt to lead to a hot box, due simply to over-pressure, the lubricant being not sufficiently viscous to hold the surfaces far enough apart to prevent too great interference of the surfaces with each other and consequent generation of too great heat. Again, it not infrequently happens that journals and bearings must be used which do not fit each other, as when a new bearing is put on a worn journal. This causes too high pressures on certain points, with consequent generation of more heat than can be disposed of in the ordinary way. Also it sometimes happens that the journal or bearing may contain slag or mineral matter mechanically enclosed, which causes grinding action and consequently excessive heat. Still again, when new cars go out, the journals and bearings are more or less rough, even with the best appliances for fitting them together in the shop, and consequently until they have worn off the inequalities, and have become adapted to each other, it is not infrequent that hot boxes occur. All these causes are to a certain extent unavoidable concomitants of the service, and hot boxes arising from these causes can really not be regarded as blameworthy. In our judgment, however, not over 10 per cent. of the hot boxes can be accounted for in this way. By far the principal portion of hot boxes, we think, is a direct result of lack of care, and if our theory is correct, every journal, even though supplied plentifully with lubricant, but sufficiently neglected in other respects will sooner or later run hot. The theory which we use to explain the largest portion of hot boxes is as follows: It is well known that all journals and bearings are subjected to wear, and that the portions which wear off are usually very small bits of metal, which at first simply discolor the oil. It is also well known that no car box has yet been devised which completely excludes the dust from the air. Both of these—namely, the wearings from the journals and bearings, and the dirt from the air—constantly mix with the oil or lubricant used, so that from the first moment when a new journal starts, the oil in the box is becoming more and more a mixture of mineral matter with the lubricant. If now the oil is 90, 80 or 70 per cent. and the mineral matter 10, 20 or 30 per cent. of the material which goes between the surfaces as the journal revolves, it is entirely possible that no difficulty will occur, since such a mixture is a very fair lubricant. On the other hand, as time progresses there is constant change, resulting in an increase of mineral matter, and ultimately the lubricant which goes between the surfaces becomes a mixture of 75 or 80 per cent. perhaps mineral matter and 25 or 20 per cent. of oil. Such a lubricating material is in reality a paste, and with such a lubricating material enormous amounts of heat are generated. In the common language of the shops, the journal is "dry." In actual fact the journal is lubricated with a mixture composed largely of mineral matter and a small amount of lubricant. The above explanations are based on the supposition that a journal receives no fresh supply of oil and no care, and there is no doubt, we think, but that under these conditions any and every car journal in service will sooner or later get hot. But it will be urged that no journal runs without care and constant supplies of oil added to keep down the percentage of mineral matter in the lubricant. To this we reply, the addition of oil undoubtedly puts off the evil day, and if the oil added would keep the waste clean, very few hot boxes would probably occur. But unfortunately the waste in the car box retains the mineral matter and wearings in the car boxes in spite of everything which can be done, and no amount of oil added will ever keep waste free from accumulations of mineral matter. It results even with the best of care, and constant additions of oil, unless the dirty waste is taken out and its place supplied with fresh clean waste from time to time, that the waste in every car box becomes continually more and more dirty, so that the lubricant which the journal and bearing gets is ultimately so largely composed of mineral matter that excessive heat is generated.

In proof of the theory of hot boxes advanced above, the following experimental data have been obtained. *First*, oil squeezed out of the waste of some car boxes which had been moderately warm was tested on the oil-testing machine, in direct comparison with clean, fresh oil, the amount of heat generated by the two oils, under the same conditions, being determined approximately. The result showed that the dirty oil from the car boxes generated nearly double the amount of heat that was a concomitant of the clean, fresh oil. In other words, the more mineral matter there is in a lubricant which goes between the surfaces, the greater amount of heat will be generated. This experiment can be repeated any time by any one who has the appliances, and it was repeated by us with various modifications, graphite, tripoli, and other mineral substances being purposely added to the oil, to get some idea of the relative amount of heat generated with each of these different substances as lubricant. These experiments are hardly in sufficient shape to warrant publication as conclusive results, but upon the main fact—namely, that with dirty oil more heat is generated than with clean oil, there seems to be no doubt. Moreover, this difficulty in regard to heat with dirty oil seems to be cumulative—that is to say, the warmer the journal using dirty oil gets, the more limpid the oil becomes, and the less there is of it between the surfaces, thus causing the mineral matter to be more and more continually an element in the lubrication; and, as every practical mechanic knows, when the lubricant becomes largely mineral matter, or, in technical language, the journal is "dry," very great friction results, with consequent great generation of heat.

Second, at one time, either in December or January, on a certain railroad, there was a very serious epidemic of hot boxes, so much so as to cause real difficulty with the traffic, and a very careful investigation was made as to the cause. It was finally found that during the months of September and October previous, the traffic had been so heavy that the car inspectors were not able to repack the ordinary number of cars per day with fresh waste, and that even up to the time when the epidemic occurred they had not been able to catch up. The consequence was that the car boxes were actually running on dirty waste, and although the normal amount of oil had been constantly used, the epidemic of hot boxes had resulted as above stated. A little additional force put on, and a repacking with fresh waste of quite a percentage of the equipment, caused the epidemic to disappear.

Third, on a certain railroad which runs through a very sandy country, and which, at certain seasons of the year, has a great traffic, there was great difficulty from hot boxes, due, apparently, to sand and dirt getting into the boxes. A piece of pasteboard laid in under the car box lid, over the waste, caused this epidemic to disappear. This piece of pasteboard fitted moderately tight around the edges of the box under the cover, and at the end of the run would be found covered with sand. Care being taken to throw this sand out when inspecting the boxes, no greater difficulty was experienced on this road than on others with hot boxes.

If the reasoning above is correct, it seems to follow that a large portion at least of hot boxes result from lack of sufficient care and attention to the boxes. If the waste is renewed with sufficient frequency, good appliances made use of to keep the dirt out, and a good fair lubricant used, it would seem that hot boxes might be reduced to a very small number, and we really do not know of anything which can be done that will take the place of this care and attention. Until some method of car lubrication is devised which does away with the waste, there is very little possibility of keeping the number of hot boxes to a minimum, without a good deal of expense and labor in the matter of the renewal of waste, and care of the boxes in service.

A journal and bearing having become very hot, what is the best remedy? The answers to this question are very numerous. With some the use of tallow alone is believed to be very efficacious, and we think there is no doubt that many hot boxes can be cured by the use of tallow, or indeed a car candle laid in alongside of the car journal. Others have their favorite remedy in some form of hot-box grease, which is supposed to have the power of cooling the journal if it is only put in the box, however hot the journal may be. No hot-box grease that has ever been tried, however, so far as the experience of the Pennsylvania Railroad goes, will make this claim good. Greases have been tried which cool off a fair portion of the boxes to which they are applied, but no grease which we have tried will universally cause the box to run cool after it has once become hot. The general theory on which hot-box greases are constructed is apparently to make them of such lubricating materials as will stand very high temperatures without vaporizing, and as will give a product more viscous than the oil which was in the boxes before. In our analyses of hot-box greases we have found high fire-test petroleum as an almost universal constituent. In addition to this some of them contain soaps of various kinds, lime soap being a favorite one; sometimes soda soap is a constituent, sometimes North Carolina tar is a constituent, almost always water to a greater or less extent; sometimes tallow, lard oil, neat's-foot oil, cotton-seed oil, or some other saponifiable fat, and in most cases mineral matter, either soapstone, graphite, whiting or mica. Sharp sand is also not a rare constituent, apparently not introduced on purpose, but due to carelessness in manufacture. Sulphur also frequently occurs as a constituent, and some greases which have been highly lauded as absolute cures for hot-boxes are apparently nothing but sulphur and fats. Rosin and rosin oil are sometimes used. The number of hot-box greases in the market is legion, and it is a very poor month which does not bring out from one to two new greases. We are free to confess we do not know of any grease in the market that is perfectly satisfactory.

It will be seen from what has preceded that we are strongly of the opinion that the number of hot boxes in service can be made very small by sufficient care and expense, and if this is true, the best antidote to hot boxes would seem to be to furnish the requisite care and attention. On the other hand, it will be noted that there seems to be some causes for hot boxes which are practically uncontrollable under the ordinary conditions of service, and for these hot boxes some remedy must be devised. Unquestionably if a car, the boxes of which have become hot, can be taken out of service, the boxes allowed to cool, the journals and bearings refitted and repacked with clean waste and oil, very little difficulty would be experienced with it; but this is not a possibility in the ordinary management of the service, especially the freight service. The great desideratum is some material which can be put into a box that has once become hot while it is hot, causing a few minutes' delay to treat the box, and then allowing the car to go ahead. For this purpose undoubtedly a good grease is the best thing known at present.

Our ideas as to what a hot-box grease should be may be stated something as follows:

First, it should contain no mineral matter whatever. We are quite well aware that upon this point there is a very broad difference of opinion even among experts, some claiming that after a box has become hot, especially if the bearing and journal have become scored or scratched, a little mineral matter with some lubricant serves to wear the surfaces smooth much sooner than would otherwise result. Our own view is that the addition of the mineral matter is simply laying the foundation for another hot box sooner or later, and although it works all right while the viscous lubricant which is a constituent of the grease is present, as soon as this viscous lubricant has been carried out of the box by subsequent additions of oil, the mineral matter stays to be the cause of difficulty a second time. The most experienced inspectors on the road usually prefer a grease with a little mineral matter in it, but those who are best observers claim that as soon as the box becomes cool all the grease that can be gotten hold of should be taken out of the box and thrown away. In the freight service this is impossible, and also it is very nearly impossible in the passenger service, so that we prefer to do without the possible benefit of the mineral matter in the grease while the box is cooling off, to having the resulting difficulty of the mineral matter being in the box. Moreover, definite trials have been made of greases containing no mineral matter, rather better results being obtained than with grease containing mineral matter, so that we do not know of any positive experimental data which prove that mineral matter is a valuable constituent of hot-box grease.

Second, a good hot-box grease should contain something to carry off heat. For this purpose undoubtedly water is the best substance known, and we see no reason why a good hot-box grease should not have from 20 to 30 per cent. of its weight of water as an essential constituent.

Third, after the water has evaporated it should leave a material which has a tendency to adhere to the hot surface, and which is a fairly viscous lubricant at high temperatures. Upon this point it will be noted that one of the causes given above for hot boxes is too great interference of the surfaces with each other, and this is especially true of journals and bearings after they have become somewhat scratched. If now a lubricant is used which will hold the surfaces a little farther apart, and render the interference of the surfaces a little less, much less heat will be generated, and consequently the box will have time to cool off. Most of the greases in the market fill one of these requirements fairly well—namely, they have a tendency to hold the surfaces further apart, because they are rather dense viscous substances. The adhesiveness at high temperatures is not so easy to obtain, and many of the greases of the market seem to be almost repelled by the hot surfaces.

Fourth, a hot-box grease should contain nothing that does not ultimately dissolve in the oil added afterward as lubricant. The reason for this is obvious. The grease is only added for a certain purpose, and it is not at all the best lubricant for steady use. Owing to the impossibility mentioned above of removing the grease after it has accomplished its work, we deem it an essential, therefore, that the grease should dissolve readily in the oil subsequently added to the car box. We really do not know of any grease in the market that fills this requirement. Obviously the mineral matter under no circumstances dissolves in the oil added, and a good many of the other constituents mentioned above as characteristic of hot-box greases in the market do not dissolve in oil.

Experiments are in progress on the Pennsylvania Railroad with various greases, which approximate the conditions mentioned above, and thus far the results seem very favorable. The usual method of treating hot-box greases is to take a barrel of the grease at some inspection point, and treat every hot box that comes along to that point on freight trains with a proper amount of the grease. The box is then allowed to go ahead, even though it may be more or less hot when it starts. A record is kept, and 35 or 40 miles from this place an observation is made as to whether the box is cooled off or not under this treatment. Usually an experiment embraces 100 hot boxes, and the results obtained show that with different greases, all the way from 50 to 75 or 80 per cent. of the boxes treated are cooled off.

There is much need of study on a method of car lubrication. The "waste method," if it may be so called, is defective in many respects, and the man who will devise a successful and at the same time simple method of car box lubrication that does away with the waste will not only prove a great benefit to the railroad world, but will also have a good show of securing substantial reward.

The next article of the series will treat of battery materials, including zinc, sal ammoniac and sulphate of copper.

(TO BE CONTINUED.)

AUTOMATIC BACK-PRESSURE RELIEF VALVE.

A LATE number of the *Engineer* contains the following engraving and description of a relief valve, which may interest some of our readers, as a similar scheme has been tested in this country some years ago. Our contemporary says: "The accompanying engraving, fig. 1, illustrates a new combined drain cock and relief valve, patented by Mr. W. Wood, Summerfield-crescent, Birmingham. The engraving shows the valve at work. The steam entering the cylinder at *A* closes the valve at that end, at the same time opening the opposite end *B*, and *vice versâ* with the motion of the piston, allowing any water that may accumulate in the cylinder to pass out into the drain. The valve is always open in the same direction that the piston is traveling, which prevents accidents through priming, or neglecting to open the cylinder cocks. Its simplicity of con-

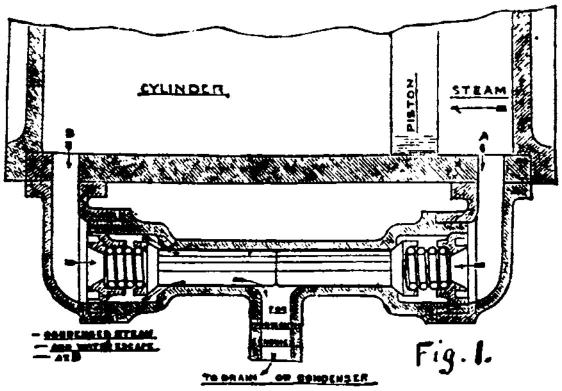

Fig. 1.

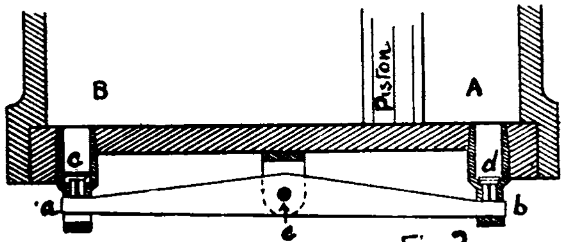

Fig. 2.

struction renders it impossible to get out of working order —it is made of hard gun-metal. The advantages claimed are: (1) It dispenses with the two ordinary cylinder cocks now in use, which leak or become corroded; (2) the water is automatically taken away, as it accumulates in the cylinder; (3) the valve is always open when the engine is standing, and thereby prevents accident when starting through neglect in opening the ordinary cocks; (4) any back-pressure caused by the steam passing the piston, or water introduced by priming, finds instant relief, thereby dispensing with relief valves in the ends of the cylinder, and reducing the breaking of joints to a minimum; (5) it is perfectly automatic and direct-acting.

About 30 years ago Mr. William Buchanan tested a similar device on the Hudson River Railroad. Fig. 2 is a drawing, made from memory, of the device he used. It consisted of two conical valves *c* and *d*, at the ends of the cylinder. These valves rested on the ends of a lever *a b*, which was pivoted at *e*. When steam was admitted into the cylinder at *A* it pressed the valve down on its seat and closed it. At the same time it depressed the end *b* of the lever and raised up the opposite end *a* and the valve *c* and opened it. The reverse operation occurred when steam was admitted at the opposite end *B* of the cylinder.

The interesting result was that when this device was applied to the locomotive, it was found that it thumped badly, and, as Mr. Buchanan reports, nearly hammered itself to pieces. The engine with this device on it did not run nearly as well as it did before, and would not make either time or steam. It was a practical exemplification of the value of compression to the successful working of a locomotive.

UNITED STATES NAVAL PROGRESS.

THE new gunboat *Bennington* was launched at the Roach Yard in Chester, Pa., June 4. The *Bennington* is 230 ft. long, 36 ft. beam and 1,700 tons displacement. She has twin screws, driven by two triple-expansion engines, with cylinders 22 in., 31 in. and 50 in. in diameter and 30 in. stroke. She will carry six 6-in. breech-loading rifled guns, eight small rapid-fire guns and eight torpedo-tubes. The *Bennington* is in all respects like the *Concord*, which was described and illustrated in the April number of the JOURNAL, page 168.

Bids were received at the Navy Department in Washington, June 10, for three new ships. The first and largest—which is the largest vessel yet designed for the Navy—was the armored cruiser, No. 2, of 8,100 tons displacement, a description of which was given in the April number of the JOURNAL. For this ship five bids were received, as follows:

The William Cramp & Sons Ship & Engine Building Company of Philadelphia, on the plans and specifications of the Navy Department, $3,150,000; on plans and specifications submitted by themselves, $2,985,000.

The Union Iron Works, San Francisco, on the Department plans, $3,100,000; on their own plans as submitted, $3,000,000.

The Risdon Iron & Locomotive Works, San Francisco, on the Department plans, $3,450,000. This company has never done any naval work. The appropriation limit for the ship is $3,500,000.

The second ship is officially designated as cruiser No. 6, and is a protected cruiser of 5,500 tons displacement. This ship was described in the June number of the JOURNAL, and will be of the same type as the *Baltimore, Philadelphia, Newark* and *San Francisco*, but larger, having about 1,000 tons more displacement. For this vessel only two bids were received, both from the Union Iron Works, San Francisco, who offered to construct the ship on the Department plans and specifications for $1,796,000, or, according to their own plans, for $1,760,000. The appropriation limit for this ship is $1,800,000.

The third vessel bid for was the practice ship for the Naval Academy. Bids had been received for this vessel previously, but no contract was let, and new bids were called for. This is a small ship of 800 tons displacement, and of very similar type to the gunboats Nos. 5 and 6. She will be 180 ft. in length, 32 ft. breadth, 11 ft. 6 in. mean draft, with triple-expansion engines of 1,300 H. P. Owing to the purpose for which she is intended, she will have an unusual amount of work upon her for a small vessel. Two bids were received for this ship: one from F. W. Wheeler of West Bay City, Mich., for $245,000; the other from Samuel L. Moore & Company of Elizabethport, N. J., for $250,000, both on the Department plans. The appropriation limit is $260,000.

The Department has awarded the contract for armored cruiser No. 2 (the 8,100-ton ship) to the Cramp & Sons Company on their second bid of $2,985,000, accepting the changes in design proposed by them. The contract for cruiser No. 6 (the 5,500-ton vessel) is given to the Union Iron Works, San Francisco, on their first bid of $1,796,000, on the Department plans. Samuel L. Moore & Company receive the contract for the practise ship on their bid.

ENGINEERING IN THE FAR EAST.

OUR correspondent in Siam, who has been actively engaged in engineering work in that distant country, writes:

I am sorry to say that railroad affairs in Siam have not progressed since I last wrote to you. The Borapah Railroad Company was reorganized on a broader financial