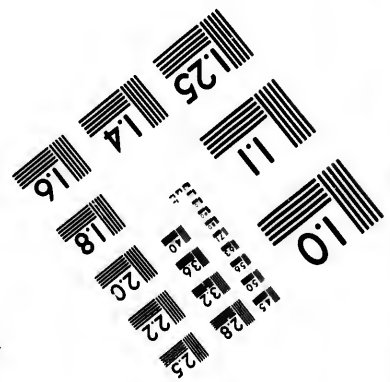
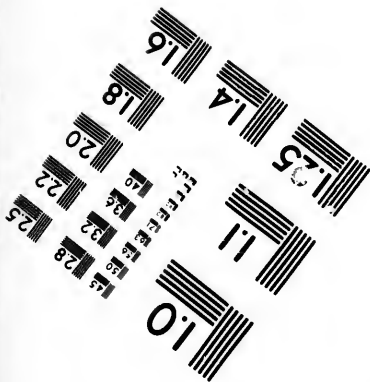
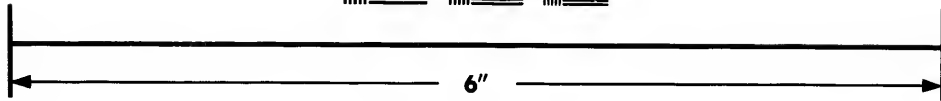
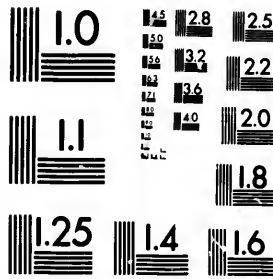


**IMAGE EVALUATION
TEST TARGET (MT-3)**



**Photographic
Sciences
Corporation**

23 WEST MAIN STREET
WEBSTER, N.Y. 14580
(716) 872-4503

**CIHM/ICMH
Microfiche
Series.**

**CIHM/ICMH
Collection de
microfiches.**



Canadian Institute for Historical Microreproductions / Institut canadien de microreproductions historiques

© 1987

Technical and Bibliographic Notes/Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming, are checked below.

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- | | |
|---|---|
| <input type="checkbox"/> Coloured covers/
Couverture de couleur | <input type="checkbox"/> Coloured pages/
Pages de couleur |
| <input type="checkbox"/> Covers damaged/
Couverture endommagée | <input type="checkbox"/> Pages damaged/
Pages endommagées |
| <input type="checkbox"/> Covers restored and/or laminated/
Couverture restaurée et/ou pelliculée | <input type="checkbox"/> Pages restored and/or laminated/
Pages restaurées et/ou pelliculées |
| <input type="checkbox"/> Cover title missing/
Le titre de couverture manque | <input checked="" type="checkbox"/> Pages discoloured, stained or foxed/
Pages décolorées, tachetées ou piquées |
| <input type="checkbox"/> Coloured maps/
Cartes géographiques en couleur | <input type="checkbox"/> Pages detached/
Pages détachées |
| <input type="checkbox"/> Coloured ink (i.e. other than blue or black)/
Encre de couleur (i.e. autre que bleue ou noire) | <input checked="" type="checkbox"/> Showthrough/
Transparence |
| <input type="checkbox"/> Coloured plates and/or illustrations/
Planches et/ou illustrations en couleur | <input type="checkbox"/> Quality of print varies/
Qualité inégale de l'impression |
| <input type="checkbox"/> Bound with other material/
Relié avec d'autres documents | <input type="checkbox"/> Includes supplementary material/
Comprend du matériel supplémentaire |
| <input type="checkbox"/> Tight binding may cause shadows or distortion along interior margin/
La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure | <input type="checkbox"/> Only edition available/
Seule édition disponible |
| <input type="checkbox"/> Blank leaves added during restoration may appear within the text. Whenever possible, these have been omitted from filming/
Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées. | <input type="checkbox"/> Pages wholly or partially obscured by errata slips, tissues, etc., have been refilmed to ensure the best possible image/
Les pages totalement ou partiellement obscurcies par un feuillet d'errata, une pelure, etc., ont été filmées à nouveau de façon à obtenir la meilleure image possible. |
| <input type="checkbox"/> Additional comments:/
Commentaires supplémentaires: | |

This item is filmed at the reduction ratio checked below/
Ce document est filmé au taux de réduction indiqué ci-dessous.

10X	14X	18X	22X	26X	30X
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12X	16X	20X	24X	28X	32X

The copy filmed here has been reproduced thanks to the generosity of:

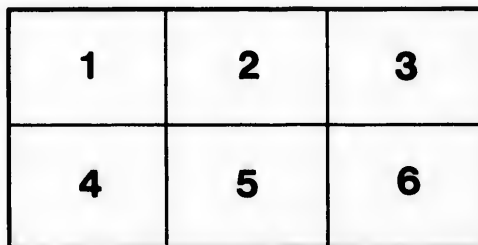
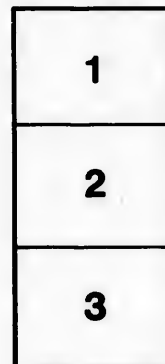
Douglas Library
Queen's University

The images appearing here are the best quality possible considering the condition and legibility of the original copy and in keeping with the filming contract specifications.

Original copies in printed paper covers are filmed beginning with the front cover and ending on the last page with a printed or illustrated impression, or the back cover when appropriate. All other original copies are filmed beginning on the first page with a printed or illustrated impression, and ending on the last page with a printed or illustrated impression.

The last recorded frame on each microfiche shall contain the symbol \rightarrow (meaning "CONTINUED"), or the symbol ∇ (meaning "END"), whichever applies.

Maps, plates, charts, etc., may be filmed at different reduction ratios. Those too large to be entirely included in one exposure are filmed beginning in the upper left hand corner, left to right and top to bottom, as many frames as required. The following diagrams illustrate the method:



L'exemplaire filmé fut reproduit grâce à la générosité de:

Douglas Library
Queen's University -

Les images suivantes ont été reproduites avec le plus grand soin, compte tenu de la condition et de la netteté de l'exemplaire filmé, et en conformité avec les conditions du contrat de filmage.

Les exemplaires originaux dont la couverture en papier est imprimée sont filmés en commençant par le premier plat et en terminant soit par la dernière page qui comporte une empreinte d'impression ou d'illustration, soit par le second plat, selon le cas. Tous les autres exemplaires originaux sont filmés en commençant par la première page qui comporte une empreinte d'impression ou d'illustration et en terminant par la dernière page qui comporte une telle empreinte.

Un des symboles suivants apparaîtra sur la dernière image de chaque microfiche, selon le cas: le symbole \rightarrow signifie "A SUIVRE", le symbole ∇ signifie "FIN".

Les cartes, planches, tableaux, etc., peuvent être filmés à des taux de réduction différents. Lorsque le document est trop grand pour être reproduit en un seul cliché, il est filmé à partir de l'angle supérieur gauche, de gauche à droite, et de haut en bas, en prenant le nombre d'images nécessaire. Les diagrammes suivants illustrent la méthode.

errata
to

pelure,
on à



32X

INSPE

EXAM

RULES

—FOR THE—

INSPECTION OF STEAMBOATS

—AND FOR THE—

EXAMINATION OF ENGINEERS OF STEAMBOATS.

F5013
1891
C212R

AT THE GOVERNMENT HOUSE,

OTTAWA, Thursday, 14th day of May, 1891.

PRESENT :

HIS EXCELLENCY THE GOVERNOR GENERAL IN COUNCIL.

His Excellency in virtue of the powers vested in him by "The Steamboat Inspection Act," Chapter 78 of the Revised Statutes, and the Acts amending the same, and by and with the advice of the Queen's Privy Council for Canada, is pleased to Order that the existing Rules and Regulations which govern the inspection of Steamboats and the examination of applicants for certificates as Engineers of Steamboats, be repealed, from and after the 1st day of June, 1891, and that the following Rules and Regulations for the Inspection of Steamboats and the Examination of Steamboat Engineers, prepared and made by the Board of Steamboat Inspection, be adopted and established in lieu thereof.

His Excellency is further pleased to Order, by and with the advice of the Queen's Privy Council for Canada, that the rate or duty to be paid yearly by owners or masters of steamboats under the provisions of Section 46 of Chapter 78 of the Revised Statutes, be continued at the rate of eight cents for every ton gross which each Steamboat measures.

JOHN J. MCGEE,

Clerk of the Privy Council.

May 1975
Richardson
The Hon. J. B. Richardson

1875
May 17 1875
415
Richardson
Council

UNCIL.
by "The
Statutes,
dvice of
der that
pection
ificates
r the 1st
ulations
Steam-
eamboat
with the
the rate
amboats
Revised
ery ton
Council.

1891.

RULES
FOR THE
INSPECTION OF STEAMBOATS
AND FOR THE
EXAMINATION OF ENGINEERS OF STEAMBOATS.

PART I.

Mode of Inspection.

Sec. 1. Any Inspector may, whenever he deems it necessary so to do, and one Inspector shall, at least once in every year, subject the boiler of every steam-boat to a test by hydrostatic pressure, in the ratio of one hundred and fifty pounds to one hundred pounds allowable as a working pressure, using the water in such test at a temperature not exceeding sixty degrees Fahrenheit, and shall satisfy himself by examination and experimental trials that such boiler is well made of good and suitable materials. For the purposes of such test the owner of the steam-boat shall provide the necessary hand-pump and apparatus, the same to be worked by the crew of the vessel; and no Inspector of boilers and machinery shall make or deliver to the owner or master of any steam-boat any certificate, unless he has first subjected the boiler or boilers of such steam-boat to such test by hydrostatic pressure and examination as herein prescribed.

Sec. 2. Before a boiler is subjected to a test by hydrostatic pressure, it shall be opened up for inspection, the man-hole and mud-plate doors removed, and the outside and the inside of the boiler cleaned, the furnace grates removed and the furnace swept out clean, so that satisfactory and efficient inspection may be made; when bulkheads are so placed as to prevent a close examination of the plate of the boiler, they shall be removed; and the owner or master of the steam-boat shall see that the foregoing requirements are complied with before applying for inspection.

Sec. 3. In any case in which the test is not satisfactory, the defects shall be made good and the boiler re-tested satisfactorily, before a certificate is granted.

Sec. 4. Inspectors are to fix the working pressure of boilers by a series of calculations of the strength of the various parts, and according to the workmanship and material of which they are composed.

Sec. 5. Before testing a boiler the Inspectors should examine it, take the necessary measurements and calculate what the working pressure should be, in accordance with these regulations; these instructions apply to super-heaters, steam-chests, and water-jackets, as well as boilers.

Sec. 6. If a boiler is too hot for an Inspector to examine it efficiently with safety and convenience, he should decline to do so, and absolutely refuse to grant a certificate until he can make a satisfactory examination.

Sec. 7. In order to satisfy himself as to strength and internal condition of a boiler, the Inspector may, should he deem it necessary, order holes to be cut in it, and may also demand that such information by drawings and specifications of the several parts be furnished him of the construction, as will enable him to determine, by calculation and examination, their strength.

Sec. 8. During the construction of every boiler made in Canada, the maker of such boiler shall notify the Inspector of the District in which it is being made, that it is open to his inspection, and shall, at all times during such construction allow the Inspector free access to it.

Sec. 9. To prevent questions arising after a boiler is commenced, particulars of its construction by drawings and specifications should be furnished the Inspector by the maker or contractor, for his approval; the Inspector having received such drawing or specifications, and approved of them, will be careful to see that they are followed in construction, or deductions made in accordance with Section 25. This regulation will also apply to boilers undergoing alterations.

Sec. 10. No boiler shall be made of boiler plate, whether iron or steel, which has not been stamped with the name or mark of the maker thereof; and no certificate shall be granted with respect to any boiler made wholly or in part of plate not so marked; and before a certificate shall be granted with respect to any boiler, a declaration on oath by the maker of the boiler, stating the name of the maker of the plates, their quality and the quality of all materials used in the construction of the boiler, shall be furnished the Inspector; such oath may be taken before any Justice of the Peace in Canada, or before a Notary Public and certified under his official seal, if taken out of Canada: Provided always, that in any case where such declaration on oath by the maker of the boiler cannot be obtained owing to the death of the maker, or from other causes deemed sufficient by the Inspector, the affidavit of two practical boiler makers who have examined the boiler and reported upon the quality of the materials in it and its workmanship and strength, shall, if satisfactory to the Inspector, be deemed sufficient in lieu of such declaration by the maker of the boiler.

Sec. 11. No boiler or pipe in connection therewith shall be approved which is made in whole or in part of bad material or workmanship, or is unsafe in its form, or from age, use or from any other cause.

Sec. 12. Inspectors should see all new boilers, and boilers that have been taken out of a ship for thorough repair, tested by hydraulic pressure up to at least one and one half the working pressure that will be allowed, previous to the boiler being placed in the vessel, to test the workmanship, etc., but the working pressure is to be determined by the stay power, the thickness of the plate, strength of riveting, etc., and not by the hydraulic test.

Sec. 13. The hydraulic test should in no case exceed the ratio of one and one half the working pressure allowed, and it is never to be applied until the boiler has been opened up for examination and until the strength of all the parts has been calculated from the necessary measurements taken from the boiler itself.

Sec. 14. When a boiler is partially inspected by one Inspector, and the inspection is completed and the certificate to be granted by another Inspector, if the Inspector who witnesses the test of the boiler by the hydrostatic pressure has an opportunity of examining the boiler inside and outside after the test, such Inspector shall determine the working pressure to be allowed on the boiler, taking care to inform the owner or master, or maker or agent, and the Inspector, who partially inspected it, what working pressure should in his opinion be allowed, and the Inspector who partially inspected the boiler should inform the Inspector who completes the inspection of all particulars of his inspection of the boiler.

Sec. 15. Cast iron must not be used for stays in boilers; Inspectors should also discourage the use of cast iron for chocks and saddles for

bol
ing
'oo
S
cir
pre
the
is o
he
boi
allo
sho
as
unt
S
of a
pres
full
S
full
sho
cate
is c
S
stre
solid
not
in t
Se
by t
T
S
C
C
flam
at l
thic
C
flam
C
and
nuts
of th
C
and
only
(l
pitc
cov
(c
plat
the
(a
con
C
with
pla

boilers; particular attention should be paid to chocking and fastening boilers to the vessels to guard against shifting or breaking loose.

Sec. 16. A pressure once allowed on a boiler is not, under any circumstances whatever, to be increased, unless the Inspector has previously written for and obtained the sanction of the Chairman of the "Board of Steam-boat Inspection." In cases where an Inspector is of opinion that an increased pressure may with safety be allowed, he should communicate with the Inspector who last inspected the boiler, and if, on learning why the existing pressure was formerly allowed, the Inspector is still of opinion that it may be increased, he should communicate all the facts of the case to the Chairman; but, as above stated, the pressure should not, in any case, be increased until the question has been decided by the Chairman.

Sec. 17. In the event of any novelty in construction of a boiler, or of any departure from the practice of staying and strengthening as prescribed in these rules and regulations, the Inspector shall report full particulars to the Chairman before fixing the working pressure.

Sec. 18. An Inspector shall not declare a boiler safe unless he is fully informed as to its construction, material and workmanship. He should, therefore, be very careful how he ventures to give a certificate for a boiler that he is not called in to inspect until after it is completed and fixed in the ship.

Sec. 19. In the case of new boilers, the Inspector may allow a stress not exceeding 7,000 pounds per square inch of net section on solid iron screw stays supporting flat surfaces, but the stress should not exceed 6,000 pounds when the stays have been welded or worked in the fire.

Sec. 20. (a.) The pressure on plate forming flat surfaces is found by the following formula:—

$$\frac{C \times (T + 1)^2}{S - 6} = \text{Working Pressure.}$$

T = Thickness of plate in sixteenths of an inch.

S = Surface supported in square inches.

C = Constant according to the following circumstances:—

C = 100 when the plates are not exposed to the impact of heat or flame, and the stays are fitted with nuts and washers, the latter being at least three times the diameter of the stay and two thirds the thickness of the plate they cover.

C = 90 when the plates are not exposed to the impact of heat or flame, and the stays are fitted with nuts only.

C = 60 when the plates are exposed to the impact of heat or flame, and the steam in contact with the plates, and the stays fitted with nuts and washers, the latter being at least three times the diameter of the stay, and two thirds the thickness of the plates they cover.

C = 54 when the plates are exposed to the impact of heat or flame, and steam in contact with the plates, and the stays fitted with nuts only.

(b.) If the diameter of riveted washers be at least two thirds the pitch of the stays, and the thickness not less than the plates they cover, the constants may be increased to 150.

(c.) When doubling plates are fitted of the same thickness of the plates they cover, and not less in width than two thirds the pitch of the stays, the constants may be increased to 160.

(d.) When doubling plates cover the whole of the flat surfaces, the constant may be increased to 200.

C = 80 when the plates are exposed to the impact of heat or flame, with water in contact with the plates, and the stays screwed into the plates and fitted with nuts.

C = 60 when the plates are exposed to the impact of heat or flame with water in contact with the plates, and the stays screwed into the plates, having the ends riveted over to form substantial heads.

C = 36 when the plates are exposed to the impact of heat or flame, and steam in contact with the plates, with the stays screwed into the plates, and having the ends riveted over to form substantial heads.

(e.) In cases where plates are stiffened by T or L irons, and a greater pressure is required for the plate than is allowed by the use of the above constants, the case should be submitted for the consideration of the Chairman.

(f.) When the riveted ends of the screw stays are much worn, or when the nuts are burned, the constants should be reduced, but the Inspector must act according to the circumstances that present themselves at the time of the inspection, and it is expected that in cases where the riveted ends of screw stays in the combustion boxes and furnaces are found in this state it will be often necessary to reduce the constant from 60 to 36.

Sec. 21. Inspectors should not in any case allow a greater compressive stress on the tube plates than 7,500 pounds, which is that used in the following formula:—

$$\frac{(D-d) T \times 15,000}{W \times D} = \text{Working Pressure.}$$

D = Least horizontal distance between centres of tubes in inches.

d = Inside diameter of ordinary tube in inches.

T = Thickness of plate tube in inches.

W = Extreme width of combustion box in inches from front of tube plate to back of fire box, or distance between combustion box tube plates when boiler is double ended and the box common to the furnaces at both ends.

Sec. 22. When stays prevent an Inspector from getting inside a boiler, he must order their removal, and he must see them properly replaced before granting a certificate.

Sec. 23. In the case of zig-zag riveting the strength through the plate diagonally between the rivets is equal to that horizontally between the rivets, when the diagonal pitch equals six tenths the horizontal pitch plus four tenths the diameter of the rivet.

Sec. 24. When the outside of the bottom of a boiler can not be otherwise thoroughly inspected, the boiler should be lifted once at least in every four years.

Construction of Boilers.

Sec. 25. (a.) When cylindrical boilers or the cylindrical parts of boilers composed of iron plates are made of the best material with all the rivet holes drilled in place and all the seams fitted with double butt straps, each of at least five eighths the thickness of the plates they cover, and all the seams at least double riveted with rivets having an allowance of not more than 75 per cent. over the single shear, and provided that the boilers have been open to inspection, then 5 may be used as the factor of safety. The tensile strength of the material is to be taken as equal to 47,000 pounds per square inch with the grain, and 40,000 pounds across the grain. When the above conditions are not complied with, the addition, in the following scale, must be added to the factor, according to the circumstances of each case:—

A 15—To be added when all the holes are fair and good in the longitudinal seams, but drilled out of place after bending.

B 3—To be added when all the holes are fair and good in the longitudinal seams, but drilled out of place before bending.

- C·3—To be added when all the holes are fair and good in the longitudinal seams, but punched after bending instead of drilled.
- D·5—To be added when all the holes are fair and good in the longitudinal seams, but punched before bending.
- E·75—To be added when all the holes are not fair and good in the longitudinal seams.
- F·1—To be added if the holes are all fair and good in the circumferential seams, but drilled out of place after bending.
- G·15—To be added if the holes are fair and good in the circumferential seams, but drilled before bending.
- H·15—To be added if the holes are fair and good in the circumferential seams, but punched after bending.
- I·2—To be added if the holes are fair and good in the circumferential seams, but punched before bending.
- J·2—To be added if the holes are not fair and good in the circumferential seams.
- K·2—To be added if double butt straps are not fitted to the longitudinal seams, and the said seams are lapped and double riveted.
- L·1—To be added if double butt straps are not fitted to the longitudinal seams, and the said seams are lapped and treble riveted.
- M·3—To be added if only single butt straps are fitted to the longitudinal seams, and the said seams are double riveted.
- N·15—To be added if only single butt straps are fitted to the longitudinal seams, and the said seams are treble riveted.
- O1—To be added when any description of joint in the longitudinal seams is single riveted.
- P†1—To be added if the circumferential seams are fitted with single butt straps and are double riveted.
- Q†2—To be added if the circumferential seams are fitted with single butt straps and are single riveted.
- R†1—To be added if the circumferential seams are fitted with double butt straps and are single riveted.
- S†1—To be added if the circumferential seams are lapped joints and are double riveted.
- T·2—To be added if the circumferential seams are lapped joints and are single riveted.
- U·25—To be added when the circumferential seams are lapped, and the strakes of plates are not entirely under or over.
- V·3—To be added when the boiler is of such a length as to fire from both ends, or is of unusual length, such as flue boilers; and the circumferential seams are fitted as described opposite P., R. and S., but of course when the circumferential seams are as described opposite Q. and T., V·3 will become V·4.
- W*·4—To be added if the seams are not properly crossed.
- X*·4—To be added when the iron is in any way doubtful, and the Inspector is not satisfied that it is of the best quality.
- Y†1·65—To be added if the boiler is not open for inspection during the whole period of its construction.

(b.) The strength of the joints is found by the following method:—

$$\frac{(\text{Pitch} - \text{Diameter of rivets}) \times 100}{\text{Pitch}} = \text{Percentage of strength of plate at joint as compared with the solid plate.}^{**}$$

$$\frac{(\text{Area of rivets} \times \text{No. of rows of rivets}) \times 100}{\text{Pitch} \times \text{thickness of plate}} = \text{Percentage of strength of rivets as compared with the solid plate. }^{\dagger\dagger}$$

(c.) Where marked * the allowance may be increased still further if the workmanship or material is very doubtful or unsatisfactory.

** The maximum pitch of the rivets should not exceed $8\frac{1}{2}$ inches, and if in any case the Inspector finds the pitch in excess of this, he should report to the Chairman.

†† If the rivets are exposed to double shear, multiply the percentage as found by 1·75.

† When inspecting boilers that have not been open to inspection during construction the case should be submitted to the Chairman as to the factors to be used.

‡ P† 1, Q† 2, R† 1, S† 1, shall not apply to the end or circumferential seams, if such seams are sufficiently stayed by through bolts; nor to the seams between the square and round part of the shell, in cylindrical boilers with square furnaces, when such seams are double riveted.

(d.) Then take iron as equal in tensile strength to 47,000 pounds per square inch and use the smallest of the two percentages as the strength of the joint, and adopt the factor of safety as found from the preceding scale:—

$$\frac{47,000 \times \text{percentage of strength of joint} \times \text{twice the thickness of the plate in inches.}}{\text{inside diameter of boiler in inches} \times \text{factor of safety.}}$$

—Pressure to be allowed per square inch on the safety-valves.

(e.) Plates that are drilled in place must be taken apart and the burr taken off and the holes slightly countersunk from the outside.

(f.) Butt straps must be cut from plates and not from bars, and must be of as good quality as the shell plate, and for the longitudinal seams must be cut across the fibre.

(g.) The rivet holes may be punched or drilled when the plates are punched or drilled out of place, but when drilled in place, must be taken apart and the burr taken off and slightly countersunk from the outside.

(h.) When single butt straps are used and the rivet holes in them punched, they must be one eighth thicker than the plates they cover.

(i.) The diameter of rivets must not be less than the thickness of the plate of which the shell is made, but it will be found when the plates are thin, or when lap joints or single butt straps are adopted, that the diameter of the rivets should be in excess of the thickness of the plate.

(j.) The distance of the rivet holes from the end or edge of the plates shall not be less than the diameter of the rivets.

(k.) Dished ends that are not truly hemispherical must be stayed; if they are not theoretically equal in strength to the pressure needed they must be stayed as flat surfaces, but if they are theoretically equal in strength to the pressure needed the stays may have a strain of 10,000 lbs. per effective square inch of sectional area.

(l.) Inspectors will remember that the strength of a sphere to resist internal pressure is double that of a cylinder of the same diameter and thickness.

Sec 26. (a.) The neutral parts of boiler shells under steam domes must be sufficiently stiffened and stayed.

(b.) The sides of boilers having square furnaces and half round tops must be stayed from side to side of the shell, over the furnace, one or more rows of these stays to be placed well above the centre of the cylindrical part.

(c.) Screw stays are not to be used when supporting flat surfaces at any angle but a right angle to the surface supported, their diameter to be measured inside the thread.

(d.) The longitudinal seams in the cylindrical shell of boilers should be as far as possible from the bottom.

(e.) The inside diameter of the outside strake or course in the cylindrical shell of a boiler is to be taken as the measure of its diameter.

Sec 27. (a.) In cylindrical super-heaters the strength of the joints and the factor of safety is found in a similar manner as for cylindrical boilers and steam receivers, but instead of using 47,000 pounds as the tensile strength of iron, 24,000 pounds is adopted, unless where the heat of flame impinges at or nearly at right angles to the plate, then 18,000 pounds is substituted.

(b.) In all cases the internal steam pipes should be so fitted that the steam in flowing to them will pass over a l the plates exposed to the impact of heat or flame.

(c.) Super-heaters or water jackets should, as regards inspection, be deemed to be the most important part of the boilers, and must be inspected inside and outside; those that cannot be entered (on account of their size) must have a sufficient number of doors through which a thorough inspection of the whole of the interior can be made.

(d.) Special attention should be paid to the inspection of super-heaters, as with high pressure the plates may become dangerously weak and not give any sound to indicate their state when tested with the hammer; the plate should, therefore, be occasionally drilled. Drain pipes must be in all cases fitted to super-heaters in which a collection of water in the bottom is possible.

(e.) Super-heaters that can be shut off from the main boiler must be fitted with a Government lock-up safety valve of sufficient size, but the least size passed shall not be less than two inches in diameter.

Sec. 28. The areas of diagonal stays are found in the following way:--

Find the area of a direct stay needed to support the surface, multiply this area by the length of the diagonal stay and divide the product by the length of a line drawn at right angles to the surface supported to the end of the diagonal stay, the quotient will be the area of the diagonal stay required.

Sec. 29. (a.) When the tops of combustion boxes or other parts of a boiler are supported by solid rectangular girders, the following formula, which is used by the Imperial Board of Trade, will be useful for finding the working pressure to be allowed on the girders, assuming that they are not subjected to a greater temperature than the ordinary heat of steam, and the ends fitted to the edges of the tube plate and the back plate of the combustion box:

$$\frac{C \times d^2 \times T}{(W-P) D \times L} = \text{Working Pressure.}$$

W=Width of combustion box in inches.

P=Pitch of supporting bolts in inches.

D=Distance between the girders from centre to centre in inches.

L=Length of girder in feet.

d=Depth of girder in inches.

T=Thickness of girder in inches.

C=500 when the girder is fitted with one supporting bolt.

C=750 when the girder is fitted with two or three supporting bolts.

C=850 when the girder is fitted with four supporting bolts.

(b.) The working pressure for the supporting bolts, and for the plate between them, shall be determined by the rule for ordinary stays.

Sec. 30. The flat ends of all boilers, as far as the steam space extends, and the ends of super-heaters should be fitted with shield, or baffle plates, where exposed to the hot gases of the up-take, as all the plates subjected to the direct impact of heat or flame are liable to injury, unless covered with water.

Sec. 31. Donkey boilers that are in any way attached to, or connected with the main boilers, or with the machinery used for propelling the ship, must be inspected and fitted the same way as the main boilers, and must have a water and steam gauge, and all other fittings complete, and as regards safety valves, must comply with the same regulations as the main boilers, and no safety-valve shall be passed less than two inches in diameter, except as herein-after provided by the rules relating to the inspection of safety-valves.

Sec. 32. (a.) No boiler or steam chamber is to be so constructed, fitted or arranged as that the escape of steam from it through the safety-valve can be wholly or partially intercepted by the action of any other valve.

(b.) A stop valve must always be fitted between the boiler and the steam pipe, and (when two or more boilers are connected with a steam receiver or super-heater) between each boiler and super-heater or steam receiver. The object of this is obvious, viz., to avoid the failure of all the boilers through the failure of one. The necks of stop valves should be as short as practicable.

Sec. 33. (a.) Each boiler must be fitted with glass water gauge, at least two test cocks, and steam gauge, that is to say, each boiler must be fitted with all the fittings as complete as if there was only one boiler.

(b.) Boilers that fire at both ends, and those of unusual width, must have water gauges and test cocks at each end or side, as the case may be. When a steamer has more than one boiler, and those boilers are fitted with stop valves, each boiler must be treated as a separate one, and have all the requisite fittings.

Sec. 34. Inspectors shall be most careful not to give any official sanction to any new arrangement or construction of marine steam boilers without first obtaining the permission of the Chairman in writing, nor shall they give any written approval of any invention or arrangement unless by direction of the Chairman, and whenever they know that any invention or new arrangement is to be fitted to a vessel that is intended to have a passenger certificate, they shall as soon as possible obtain plans and specifications and submit the same to the Chairman.

Sec. 35. When the longitudinal seams in cylindrical furnaces are not welded or made with a butt strap, the following constants will be substituted for 90,000 :

- | | |
|---|---|
| (a.) Furnaces with butt joints and drilled rivet holes. | 90,000 where the longitudinal seams are double riveted and fitted with single butt straps; 80,000 where the longitudinal seams are single riveted and fitted with single butt straps; 90,000 where the longitudinal seams are single riveted and fitted with double butt straps. |
| (b.) Furnaces with butt joints and punched rivet holes. | 85,000 where the longitudinal seams are double riveted and fitted with single butt straps; 75,000 where the longitudinal seams are single riveted and fitted with single butt straps; 85,000 where the longitudinal seams are single riveted and fitted with double butt straps. |
| (c.) Furnaces with lapped joints and drilled rivet holes. | 80,000 where the longitudinal seams are double riveted and bevelled; 75,000 where the longitudinal seams are double riveted and not bevelled; 70,000 where the longitudinal seams are single riveted and bevelled; 65,000 where the longitudinal seams are single riveted and not bevelled. |
| (d.) Furnaces with lapped joints and punched rivet holes. | 75,000 where the longitudinal seams are double riveted and bevelled; 70,000 where the longitudinal seams are double riveted and not bevelled; 65,000 where the longitudinal seams are single riveted and bevelled; 60,000 where the longitudinal seams are single riveted and not bevelled. |

Steel Boilers.

Sec. 36. (a.) The following rules should guide Inspectors when the general quality of the steel has been found suitable for marine boilers :—

(b.) The steel makers or boiler makers should test one or more

strips or pieces cut from each plate and bar for tensile strength and elongation, and stamp both results on each plate or bar. When practicable the plates or bars should be so stamped that the marks can be easily seen when the boiler is constructed.

(c.) An Inspector is not obliged to witness the foregoing test, but he should see that all the plates and bars are properly stamped.

(d.) From the plates and bars, the tests of which have been stated to have been made by the steel maker, and not witnessed by the Inspector, the Inspector may, if he thinks it advisable, select any plates or bars after they are in the boiler shop and require specimens to be cut off and tested. If the results are not satisfactory, the whole of the plates, except those which were tested and found satisfactory by the Inspector, may be liable to be rejected.

(e.) Twenty-five per cent. of the rivet bars should be tested for tensile strength and elongation, the tensile strength should be from 26 to 30 tons gross, or 58,000 to 67,000 pounds to the square inch, and the elongation in ten inches should not be less than 25 per cent.

(f.) The Inspector may not in every case see some of the rivets tested, but he should occasionally select a few, and after they are prepared, see them tested. The tensile stress should be from 27 to 32 tons gross, or 62,000 to 72,000 pounds to the square inch, with a contraction of area of 60 per cent. The elongation should when practicable be taken in length equal to two and a half times the diameter of the prepared part.

(g.) Twenty-five per cent. of the bars for stays of each size should be tested, solid steel screw stays which have not been welded or otherwise worked after heating, may be allowed a working stress of 9,000 pounds to the square inch of net section, provided the tensile stress is from 27 to 32 tons gross, or 62,000 to 72,000 pounds to the square inch, and the elongation in ten inches about 25 per cent., and not less than 20 per cent.

(h.) Steel stays which have been welded or worked in the fire have been found to be unreliable, therefore they should not be passed.

(i.) If the original size of the bars for rivets or stays be reduced before testing it should be done in the lathe or by a machine; test pieces of any kind should not be prepared by heating and drawing down.

(j.) If for the plates from which the Inspectors select the above proportion, a greater stress is wished than is allowed for iron, tests for tensile stress and elongation should be made, also a few tempering and bending tests, and those for which no reduction of thickness is asked may be tested for resistance to bending and tempering only, if preferred in the latter case, the stress and elongation stamped on each plate should be reported by the Inspector to the Chairman, along with the result of the bending and tempering test.

(k.) The breadth of test strips for tensile stress should be about 2 inches, and the elongation, taken in the length of 10 inches should be about 25 per cent., and not less than 20 per cent. The strips must be carefully prepared and measured, and they should be cut from the plate by a planing or shaping machine. The skin of the test pieces should not be removed by planing, shaping or otherwise, the edges only being planed or shaped, and in no case should the test pieces be prepared or reduced in size by hammering or otherwise working on the anvil, and they must not be annealed previous to being tested, neither must the plates or bars be annealed before the test pieces are cut from them.

(l.) The bending tests for plates not exposed to flame should be made with strips in their normal condition, and occasionally also some tempering test. Strips cut from furnaces, combustion boxes, &c., should be heated to a cherry red, then plunged into water of about 80 degrees and kept there until of the same temperature as the water and then bent. The bending and tempering strips

should not be less than two inches broad and ten inches long, and they should be bent until they break, or until the sides are parallel at a distance from each other of not more than (3) three times the thickness of plate.

(m.) When full allowance over iron is wished, the tensile stress of the plates not exposed to flame should be not less than 27 tons gross, or 62,000 lbs., and should not exceed 32 tons gross, or 72,000 lbs., per square inch of section, and 29 tons gross, or 65,000 lbs., should be the stress used in the calculation for cylindrical shells, if the plates comply with all the conditions as stated therein; but when the minimum tensile strength of shell plate is not less than 28 tons gross, or 63,000 lbs., and allowance is wished for the excess, then the case should be specially submitted for the consideration of the Chairman as to whether the stress in the calculation may be increased to 30 tons gross, or to 67,000 lbs., the tensile strength of furnace, flanging and combustion box plates may range from 26 tons gross, or 58,000 lbs., to 30 tons gross, or 67,000 lbs., to the square inch.

(n.) All plates that are punched, flanged or locally heated must be carefully annealed after being so treated.

(o.) The rivet holes in the furnaces and longitudinal seams of cylindrical shells should be drilled, but if it is wished to punch them and afterwards bore or anneal the plates in a proper furnace, the particulars of the punching and boring or annealing should be submitted to the Chairman for consideration before being done, but all punched holes should be made after bending.

(p.) In all cases where assent has been given by the Chairman for plates to be punched after bending, and then annealed, the maker of the boiler should stamp the plates with the words "punched after bending and then annealed," and in all cases where assent has been given for punching and afterwards boring plates the words "punched and then bored" should be stamped on the plates.

(q.) If the flanging plates and those exposed to flame comply with the foregoing conditions, the constants in these rules for iron boilers may be increased as follows:—

1. The constants for flat surfaces, when they are supported by stays screwed into the plates and riveted, 10 per cent.

2. The constants for flat surfaces, when they are supported by stays screwed into the plates and nutted, or when the stays are nutted in the steam space, 25 per cent. This is also applicable to the constants for flat surfaces stiffened by riveted washers or doubling strips and supported by nutted stays.

3. The constants for combustion box girders, 10 per cent.

(r.) When the furnaces are new, corrugated and machine made and practically true circles, the working pressure is found by the following formula, provided that the plain parts at the ends do not exceed 6 inches in length and the plates are not less than $\frac{1}{8}$ inch thick.

$$\frac{12,500 \times T}{D} = \text{Working pressure.}$$

T=Thickness in inches.

D=Mean diameter in inches.

(If the furnace is riveted in two or more lengths, the case should be submitted to the Chairman).

(s.) A greater compressive stress should not be allowed on tube plates than 10,000 lbs. to the square inch, which is that used in the following formula:—

$$\frac{(D-d) T \times 20,000}{W \times D} = \text{Working pressure.}$$

D=Least horizontal distance between centres of tubes in inches.

d=Inside diameter of ordinary tubes in inches.

T=Thickness of tube plate in inches.

W=Extreme width of combustion box in inches from front of tube plate to back of fire box, or distance between combustion box tube plates when boiler is double ended and the box common to the furnaces at both ends.

(l.) The rivet section, if of iron, in the horizontal seams of cylindrical shells, where lapped and at least double riveted, should not be less than $\frac{1}{3}$ times the net plate section; but if steel rivets are used, their section should be at least $\frac{2}{3}$ of the net section of the plate if the tensile stress of the rivet is not less than 27 tons gross or 62,000 lbs., or not more than 32 tons gross or 72,000 pounds per square inch. Therefore, in calculating the working pressure, the percentage strength of the rivet may be found in the usual way by the rules, but in the case of iron rivets the percentages found should be divided by $\frac{1}{3}$, and in the case of steel rivets by $\frac{2}{3}$, the result being the percentages required. If the percentage strength of the rivets by calculation is less than the calculated percentage strength of the plate, calculate the working pressure by both percentages. When using the percentage strength of the plate, use the nominal factor of safety suitable for the method of construction as by the rules for iron boilers, but when using the percentage strength of the rivets, use 5 as the factor of safety. The less of the two pressures so found is the working pressure to be allowed for the cylindrical portion of the shell, or otherwise in accordance with the formulæ in appendix.

(u.) Local heating of the plates should be avoided, as many plates have failed from being so treated.

(v.) Steel plates which have been welded should not be passed if subject to a tensile stress, and those welded and subject to a compressive stress should be sufficiently annealed. In other respects the boiler should comply with the rules for iron boilers.

Sec. 37. In no case shall a certificate be granted for a boiler, when drift pins have been used in bringing the holes in the sheets together.

Sec. 38. Man-hole openings must be stiffened with compensating plates or rings of at least the same effective sectional area as the plate cut out, and in no case shall such plates or rings be of less thickness than the plate to which they are attached, nor the attachment of less strength than the plate or ring. All openings in the shells of boilers must have their short axes placed longitudinally.

Sec. 39. Every boiler, made after the coming into force of these Regulations, shall be stamped with the initial letters of the Inspector's name, who inspected and tested it, the year it was made and the pressure under which it was tested, also the actual working pressure allowed upon it.

Furnaces and Flues.

Sec. 40. (a.) The external working pressure to be allowed on plane circular steel furnaces and flues, when subjected to such pressure when the longitudinal joints are welded or made with a butt strap, shall be determined by the following formulæ:—

(b.) The product of 90,000 multiplied by the square of the thickness of the plate in inches, divided by the length of the flue, or furnace, in feet, plus one multiplied by the diameter in inches, will be the allowable working pressure per square inch in pounds; provided it does not exceed that found by the following formula:

(c.) The product of 10,000 multiplied by the thickness of the plate in inches, divided by the diameter (outside) of the flue or furnace, in inches, will be the allowable working pressure per square inch in pounds.

Corrugated Steel Furnaces and Flues.

Sec. 41. (a.) In steel flue furnaces when new, corrugated, and machine made, and practically true circles, the working pressure is found by the following formula, provided that the plane parts at the ends do not exceed 6 inches in length and the plates are not less than $\frac{1}{8}$ inch thick.

$$\frac{12,500 \times \text{thickness in inches}}{\text{Mean diameter in inches}} = \text{Working pressure per sq. inch.}$$

(b.) When the furnaces are riveted in two or more lengths the case should be submitted to the Chairman for consideration as it may be necessary to make a reduction.

Corrugated Iron Furnaces.

Sec. 42. The working pressure for corrugated iron furnaces practically circular and machine made, provided the plane parts at the ends do not exceed 6 inches in length and the plates are not less than $\frac{1}{8}$ inch thick, should not be greater than that found by the following formula:—

$$\frac{10,000 \times \text{thickness in inches}}{\text{Mean diameter in inches}} = \text{Working pressure.}$$

Cylindrical Boiler Shells.

JOINTS WITH DRILLED HOLES.

Sec. 43. Formulae for ordinary chain riveted and ordinary zig-zag riveted joints, and for joints of these descriptions, when every alternate rivet in the outer or in the outer or inner rows have been omitted:—

Let E = distance from edge of plate to centre of rivet in inches.

V = distance between rows of rivets in inches.

V₁ = distance between inner and middle row of rivets in inches for joint J.

B = boiler pressure in lbs. per square inch.

C = 1 for lap or single butt joints.

= 1.75 for double butt joints.

d = diameter of rivets in inches.

D = inside diameter of boiler in inches.

F = factor of safety for shell plates, as by section 25 of these regulations.

n = number of rivets in one pitch.

p_D = diagonal pitch in inches.

P_D = diagonal pitch in inches between inner and middle rows of rivets in inches for joint J.

p = greatest pitch of rivets in inches.

r = percentage of plate left between holes in greatest pitch.

R = percentage of rivet section.

R₁ = percentage of combined plate and rivet section.

S = tensile strength of material in lbs. per square inch of section.

T = thickness of plate in inches.

T₁ = thickness of each butt strap in inches.

o₁ = least value of r, R, R₁, as the case may be, divided by 100.

When joints are used in boiler construction other than those shown in the attached sketches, or when any of the rivets are less than two diameters apart, the particulars of such joints should be submitted for the consideration of the Board.

ORDINARY CHAIN AND ZIG-ZAG RIVETED JOINTS.

Iron plates and iron rivets or steel plates and steel rivets:—

$$\frac{100(p-d)}{p} = r.$$

Iron plates and iron rivets:—

$$\frac{100 \times d^2 \times .7854 \times n \times C}{p \times T} = R.$$

Steel plates and steel rivets:—

$$\frac{100 \times 23 \times d^2 \times .7854 \times n \times C \times F}{5 \times 28 \times p \times T} = R.$$

GIVEN C, d, F, n, T , TO FIND p , SO THAT r AND R ARE EQUAL.

Iron plates and iron rivets:—

$$\frac{d^2 \times .7854 \times n \times C}{T} + d = p.$$

Steel plates and steel rivets:—

$$\frac{23 \times d^2 \times .7854 \times n \times C \times F}{5 \times 28 \times T} + d = p.$$

GIVEN C, F, n, T, r , TO FIND p AND d .

Iron plates and iron rivets:—

$$\frac{r \times T}{(100-r) \times .7854 \times n \times C} = d.$$

$$\frac{100 \times r \times T}{(100-r)^2 \times .7854 \times n \times C} = p.$$

Steel plates and steel rivets:—

$$\frac{5 \times 28 \times r \times T}{23 \times (100-r) \times .7854 \times n \times C \times F} = d.$$

$$\frac{100 \times 5 \times 28 \times r \times T}{23 \times (100-r)^2 \times .7854 \times n \times C \times F} = p.$$

Iron plates and iron rivets or steel plates and steel rivets when d is found first, then:—

$$\frac{100 d}{100-r} = p$$

Iron plates and iron butt straps or steel plates and steel butt straps:
 Double butt straps:—

$$\frac{5 \times T}{8} = T_1.$$

Single butt straps:—

$$\frac{9 \times T}{8} = T_1.$$

FOR DISTANCE BETWEEN ROWS OF RIVETS, &C.

Iron and steel:—

$$\frac{3 \times d}{2} = E.$$

Chain riveted joints not less than:—

$$2 \times d = V.$$

(See Note (a) below.)

Zig-zag riveted joints :-

$$\frac{\sqrt{(11p+4d)(p+4d)}}{10} = V.$$

Diagonal pitch :- $\frac{6p+4d}{10} = p_D.$

TO DETERMINE THE WORKING PRESSURE.

$$\frac{S \times 0.10 \times 2.T}{F \times D} = B.$$

CHAIN AND ZIG-ZAG RIVETED JOINTS IN WHICH EVERY ALTERNATE RIVET HAS BEEN OMITTED IN THE OUTER ROW, OR IN THE OUTER AND THE INNER ROWS SUCH AS ARE SHOWN BY THE FOLLOWING SKETCHES.

Iron plates and iron rivets or steel plates and steel rivets :-

$$\frac{100(p-d)}{p} = r.$$

Iron plates and iron rivets :-

$$\frac{100 \times d^2 \times .7854 \times n \times C}{P \times T} = R.$$

Steel plates and steel rivets :-

$$\frac{100 \times 23 \times d^2 \times .7854 \times n \times C \times F}{5 \times 28 \times p \times T} = R.$$

Iron plates and iron rivets or steel plates and steel rivets :-

$$\frac{100(p-2d)}{p} + \frac{R}{n} = R_1.$$

For iron lap joints of this description the diameter of the rivet should not be less than :-

$$\frac{T}{.7854} = d.$$

For steel lap joints of this description the diameter of the rivet should not be less than :-

$$\frac{T \times 28 \times 5}{.7854 \times 23 \times F} = d.$$

JOINTS FITTED WITH SINGLE OR DOUBLE BUTT STRAPS.

Where the number of rivets in the inner row is double the number in the outer row.

Iron plates and iron butt-straps or steel plates and steel butt-straps :-

Double butt straps :-

$$\frac{5 \times T(p-d)}{8 \times (p-2d)} = T_1.$$

Single butt straps :-

$$\frac{9 \times T(p-d)}{8 \times (p-2d)} = T_1.$$

When the number of rivets in the inner row is the same as in the outer row.

Double butt-straps :-

$$\frac{5 \times T}{8} = T_1.$$

Single butt-straps :-

$$\frac{9 \times T}{8} = T_1.$$

FOR DISTANCE BETWEEN ROWS OF RIVETS, &C.

Iron and steel :—

$$\frac{3 \times d}{2} = E.$$

Chain riveted joints :—

$$\sqrt{\frac{(11p + 4d)(p + 4d)}{10}} = V \left. \begin{array}{l} \text{The greater of these two values of} \\ V \text{ to be used} \\ \text{(See NOTE (a), below.)} \end{array} \right\}$$

$$\text{or } 2 \times d = V$$

For joint K :— $2 \times d = V_1$. (See NOTE (a), below.)Zig-zag riveted joints :— $\sqrt{\frac{(\frac{1}{2}p + d)(\frac{3}{2}p + d)}{20}} = V$.Diagonal pitch :— $\frac{3}{10}p + d = p_D$.For joint J :— $\sqrt{\frac{(11p + 8d)(p + 8d)}{20}} = V_1$.Diagonal pitch :— $\frac{3p + 4d}{10} = P_D$.

TO DETERMINE THE WORKING PRESSURE.

$$\frac{S \times \sigma_0 \times 2T}{F \times D} = B.$$

NOTE (a).—The minimum value of V or V_1 for chain riveted joints is given as $2d$,but $\frac{4d + 1}{2}$, is more desirable.

PART II.

Regulations governing the inspection and testing of boilers now in existence and of boilers now or hereafter to be manufactured, in Canada, for the use of steam-boats, whenever in the opinion of the Inspector the regulations contained in Part One of these regulations, on account of the make of such boilers, or for some other reason, not capable of application in the testing thereof; provided that in every such case the Inspector shall issue his certificate, in which he shall state that his inspection has been made under Part Two of this order.

Mode of Inspection.

Sec. 44. Any inspector may, whenever he deems it necessary so to do, and one Inspector shall, at least once in every year, subject the boiler of every steam-boat to a test by hydrostatic pressure, and shall satisfy himself by examination and experimental trials that such boiler is well made of good and suitable materials; the limit of such pressure shall be in the ratio of one hundred and fifty pounds to one hundred pounds allowable as a working pressure; for the purposes of such test the owner of the steam-boat shall provide the necessary hand-pump and apparatus, and the same shall be worked by the crew of the steamboat; and no inspector shall make or deliver to the owner or master of any steam-boat, any certificate unless he has first subjected the boiler of such steam-boat to such test by hydrostatic pressure.

Sec. 45. Before a boiler is subjected to a test by hydrostatic pressure, it shall be opened up for inspection, the man-hole doors and mud-plates removed, and the outside and inside of the boiler cleaned, the furnace grates removed and the furnace swept out clean, so that satisfactory and efficient inspection may be made; when bulkheads are so placed as to prevent a close examination of the plates of the boiler, they shall be removed; and the owner or master of the steam-boat shall see that the foregoing requirements are complied with before applying for inspection.

Sec. 46. In any case in which the test is not satisfactory, the defects shall be made good and the boiler re-tested satisfactorily before a certificate is granted.

Sec. 47. When the outside of the bottom of the boiler cannot be otherwise perfectly inspected, the boiler shall be lifted for inspection once at least in every four years.

Sec. 48. In subjecting boilers made of iron plates to the hydrostatic test aforesaid, the Inspector shall assume one hundred pounds to the square inch as the maximum pressure allowable as a working power for a new boiler 42 inches in diameter, made of the best refined iron, at least one quarter of an inch thick, in the best manner and of the quality herein required, and shall rate the working pressure of all iron boilers, whether of greater or less diameter, according to their strength compared with this standard; and in all such cases the test applied shall exceed the working pressure allowed, in the ratio of one hundred and fifty pounds to one hundred, using the water in such tests at a temperature not exceeding sixty degrees Fahrenheit.

Sec. 49. In subjecting boilers made of steel to the hydrostatic test aforesaid, the Inspector shall assume one hundred and twenty-five pounds as the maximum pressure allowable as a working power for a new boiler 42 inches in diameter, made in the best manner of the best quality of steel plate, at least one quarter of an inch thick, with all the rivet holes drilled in place, the plates being then taken apart and the burrs removed, the longitudinal seams in the shell being fitted with double butt steel straps cut across the grain of the plate, and each of five eighths the thickness of the plates they cover, and all the seams being at least double riveted and having at least seventy per cent. of the strength of the solid plate, and all the flat surfaces stayed in the best manner and all the seams double riveted,—and they shall rate the working pressure of all steel boilers so made, whether of greater or less diameter, according to their strength compared with this standard; and in all such cases the test applied shall exceed the working pressure allowed for such boilers in the ratio of one hundred and eighty-seven and a half pounds to one hundred and twenty-five pounds, using the water in such tests at a temperature not exceeding sixty degrees Fahrenheit.

Sec. 50. If the Inspector is of opinion that any boiler, whether made of iron or steel plates, by reason of its construction or material, will not safely allow so high a working pressure as that hereinbefore specified for each such description of boiler respectively, he may, for reasons to be stated specifically in his certificate, fix the working pressure of such boiler at less than two thirds of the test pressure.

Sec. 51. The foregoing rules shall be observed in all cases, unless the proportion between such boilers and the cylinders, or some other cause, renders it manifest that their application would be unjust, in which case the Inspector may depart from the said rules if it can be done with safety; but in no case shall the working pressure allowed exceed the proportion hereinbefore mentioned, as compared with the hydrostatic test.

Sec. 52. (a.) The external working pressure to be allowed on plane circular iron furnaces and flues subjected to such pressure, when the longitudinal joints are welded or made with a butt strap, shall be determined by the following formula:—

(b.) The product of 90,000 multiplied by the square of the thickness of the plate in inches,—divided by the length of the flue or furnace in feet plus 1, multiplied by the diameter in inches,—shall be the allowable working pressure per square inch in pounds,—provided it does not exceed that found by the following formula:—

(c.) The product of 8,000 multiplied by the thickness of the plate in inches, divided by the diameter of the furnace or flue in inches, shall be the allowable working pressure per square inch in pounds,—

(d.) The length of the furnace to be used in the first formula being the distance between the rings, if the furnace is made with rings; and that one of the two formulæ which gives the lowest pressure being the one by which the Inspector shall be guided.

Sec. 53. On flat surfaces the allowable working pressure shall not exceed six thousand pounds to each effective square inch of sectional area of the stays supporting it; the pressure to be allowed on plates forming flat surfaces shall be that found by the following formula:—

$$\frac{C \times (T + 1)^2}{S - 6} = \text{Working pressure in pounds per square inch, where—}$$

T=Thickness of plate in sixteenths of an inch;

S=Surface supported in square inches;

C=100; but when the plates are exposed to the impact of heat or flame, and steam only is in contact with the plates or the opposite side, C is to be reduced to 50.

Sec. 54. In order to satisfy himself as to the strength and condition of a boiler, the Inspector may if he deems it necessary, order holes to be cut in it, and may also demand that such information shall be furnished him in respect to the interior construction of the boiler as will enable him to judge correctly of its strength.

Sec. 55. In no case shall a certificate be granted for a boiler when drift pins have been used in bringing the holes in the sheets together.

Sec. 56. Man-hole openings shall be stiffened with compensating rings of at least the same effective sectional area as the plate cut out, and in no case shall such rings be of less thickness than the plates to which they are attached; all openings in the shells of cylindrical boilers shall have their short axes placed longitudinally.

Sec. 57. When bars or angle irons are used for sustaining the crown sheet of the furnace of a boiler, three fifths of the working pressure allowable upon the crown sheet shall be sustained by hanging stays from the shell of the boiler attached to the crown sheet.

Sec. 58. Donkey boilers on steam-boats shall be provided with a safety-valve, which may be locked up.

Sec. 59. Boilers in which the longitudinal seams in the cylindrical shell are single riveted, in place of being double riveted, shall be subject to a reduction in the working pressure allowable for a boiler made in the best manner (as prescribed by sections 48 and 49 of these regulations) and the limit of pressure in boilers so made shall not exceed eighty pounds to the square inch in place of one hundred pounds or one hundred and twenty-five pounds, as mentioned in the said section.

Sec. 60. No boiler made and placed on board a steamboat shall be made of boiler plate, whether iron or steel, which has not been stamped with the mark or name of the maker thereof; and no certificate shall be granted with respect to any boiler made wholly or in part of plate not so marked; and before a certificate shall be granted with respect

to any boiler, a declaration on oath by the maker of the boiler, stating the name of the maker of the plates, their quality, and the quality of all materials used in the construction thereof, shall be furnished to the Inspector; such oath may be taken before any justice of the peace in Canada, or before a notary public, and certified under his official seal, if taken out of Canada: Provided always, that in any case where such declaration on oath by the maker of the boiler cannot be obtained owing to the death of the maker, or from any other cause deemed sufficient by the Inspector, the affidavit of two practical boiler makers who have examined the boiler and reported upon the quality of the materials in it, and its workmanship and strength, shall, if satisfactory to the Inspector, be deemed sufficient in lieu of such declaration by the maker of the boiler.

Sec. 61. During the construction of every boiler made in Canada, the maker of such boiler shall notify the Inspector of the district in which it is being made, that it is open to his inspection, and shall, at all times during such construction, allow the Inspector access to such boiler.

Sec. 62. No boiler or pipe shall be approved which is made in whole or in part of bad material, or is unsafe in its form, or dangerous from defective workmanship, age, use or any other cause.

Construction of boilers.

Sec. 63. (a.) When cylindrical boilers or the cylindrical parts of boilers composed of iron plates are made of the best material with all the rivet holes drilled in place and all the seams fitted with double butt straps, each of at least five eighths the thickness of the plates they cover, and all the seams at least double riveted with rivets having an allowance of not more than 75 per cent. over the single shear, and provided that the boilers have been open to inspection during the whole period of construction, then 4 may be used as the factor of safety. The tensile strength of the material is to be taken as equal to 48,000 lbs. per square inch with the grain, and 42,000 lbs. across the grain. When the above conditions are not complied with, the addition, in the following scale, must be added to the factor according to the circumstances of each case.

- A-15—To be added when all the holes are fair and good in the longitudinal seams, but drilled out of place after bending.
- B-3—To be added when all the holes are fair and good in the longitudinal seams, but drilled out of place before bending.
- C-3—To be added when all the holes are fair and good in the longitudinal seams, but punched after bending instead of drilled.
- D-5—To be added when all the holes are fair and good in the longitudinal seams, but punched before bending.
- E-75—To be added when all the holes are not fair and good in the longitudinal seams.
- F-1—To be added if the holes are all fair and good in the circumferential seams, but drilled out of place after bending.
- G-15—To be added if the holes are fair and good in the circumferential seams, but drilled before bending.
- H-15—To be added if the holes are fair and good in the circumferential seams, but punched after bending.
- I-2—To be added if the holes are fair and good in the circumferential seams, but punched before bending.
- J-2—To be added if the holes are not fair and good in the circumferential seams.
- K-2—To be added if double butt straps are not fitted to the longitudinal seams, and the said seams are lap and double riveted.

- L 1—To be added if double butt straps are not fitted to the longitudinal seams, and the said seams are lap and treble riveted.
- M 3—To be added if only single butt straps are fitted to the longitudinal seams, and the said seams are double riveted.
- N 15—To be added if only single butt straps are fitted to the longitudinal seams, and the said seams are treble riveted.
- O 1—To be added when any description of joint in the longitudinal seams is single riveted.
- P† 1—To be added if the circumferential seams are fitted with single butt straps and are double riveted.
- Q† 2—To be added if the circumferential seams are fitted with single butt straps and are single riveted.
- R† 1—To be added if the circumferential seams are fitted with double butt straps and are single riveted.
- S† 1—To be added if the circumferential seams are lap joints and are double riveted.
- T 2—To be added if the circumferential seams are lap joints and are single riveted.
- U 25—To be added when the circumferential seams are lap, and the strakes of plates are not entirely under or over.
- V 3—To be added when the boiler is of such a length as to fire from both ends, or is of unusual length, such as flue boilers; and the circumferential seams are fitted as described opposite P., R. and S., but of course when the circumferential seams are as described opposite Q. and T., V 3 will become V 4.
- W* 4—To be added if the seams are not properly crossed.
- X* 4—To be added when the iron is in any way doubtful, and the Inspector is not satisfied that it is of the best quality.
- Y† 1—To be added if the boiler is not open to inspection during the whole period of its construction.

(b.) The strength of the joints is found by the following method:—

$$\frac{(\text{Pitch} - \text{Diameter of rivets}) \times 100}{\text{Pitch}} = \text{Percentage of strength of plate at joint as compared with the solid plate.}$$

$$\frac{(\text{Area of rivets} \times \text{No. of rows of rivets}) \times 100}{\text{Pitch} \times \text{thickness of plate}} = \text{Percentage of strength of rivets as compared with solid plate } \dagger\dagger$$

(c.) Where marked * the allowance may be increased still further if the workmanship or material is very doubtful or unsatisfactory. †† If the rivets are exposed to double shear multiply the percentage as found by 1.75.

† When surveying boilers that have not been open to inspection during construction the case should be submitted to the Chairman as to the factors to be used.

P† 1, Q† 2, R† 1, S† 1, shall not apply to the end or circumferential seams, if such seams are sufficiently stayed by through bolts; nor to the seams between the square and round part of shell, in cylindrical boilers with square furnaces, when such seams are double riveted.

(d.) Then take iron as equal in tensile strength to 48,000 pounds per square inch and use the smallest of the two percentages as the strength of the joint, and adopt the factor of safety as found from the preceding scale:—

$$\frac{(48,000 \times \text{percentage of strength of joint}) \times \text{twice the thickness of the plate in inches.}}{\text{Inside diameter of boiler in inches} \times \text{factor of safety.}}$$

= Pressure to be allowed per square inch on the safety-valves.

(e.) For steel plates of the best quality the tensile strength may be taken as equal to 60,000 pounds per square inch, using the same factor of safety.

(f.) Plates that are drilled in place must be taken apart and the burr taken off and the holes slightly countersunk from the outside.

(g.) Butt straps must be cut from plates and not from bars, and must be of as good quality as the shell plates, and for the longitudinal seams must be cut across the fibre.

(h.) The rivet holes may be punched or drilled when the plates are punched or drilled out of place, but when drilled in place must be taken apart and the burr taken off and slightly countersunk from the outside.

(i.) When single butt straps are used and the rivet holes in them punched they must be one eighth thicker than the plates they cover.

(j.) The diameter of rivets must not be less than the thickness of the plates of which the shell is made, but it will be found when the plates are thin, or when lap joints or single butt straps are adopted that the diameter of the rivets should be in excess of the thickness of the plates.

(k.) The distance of the rivet holes from the ends or edge of the plates shall not be less than the diameter of the rivet.

(l.) Dished ends that are not truly hemispherical must be stayed; if they are not theoretically equal in strength to the pressure needed they must be stayed as flat services, but if they are theoretically equal in strength to the pressure needed the stays may have a strain of 10,000 pounds, per effective square inch of sectional area.

(m.) Inspectors will remember that the strength of a sphere to resist internal pressure is double that of a cylinder of the same diameter and thickness.

Sec. 64. (a.) The neutral parts of boiler shells under steam domes must be sufficiently stiffened and stayed.

(b.) The sides of boilers having square furnaces and half round tops must be stayed from side to side of the shell, over the furnace, one or more rows of these stays to be placed well above the centre of the cylindrical part.

(c.) Screw stays are not to be used when supporting flat surfaces at any angle but a right angle to the surface supported, their diameter to be measured inside the thread.

(d.) The longitudinal seams in the cylindrical shell of boilers should be as far as possible from the bottom.

(e.) The inside diameter of the outside strake or course in the cylindrical shell of a boiler is to be taken as the measure of its diameter.

Sec. 65. (a.) In cylindrical super-heaters, the strength of the joints and the factor of safety is found in a similar manner as for cylindrical boilers and steam receivers, but instead of using 48,000 pounds as the tensile strength of iron 24,000 pounds is adopted unless where the heat or flame impinges at or nearly at right angles to the plate, then 18,000 pounds is substituted.

(b.) In all cases the internal steam pipes should be so fitted that the steam in flowing to them will pass over all the plates exposed to the impact of heat or flame.

(c.) Super-heaters or water jackets should, as regards inspection, be deemed to be the most important part of the boilers and must be inspected inside and outside; those that cannot be entered (on account of their size) must have a sufficient number of doors through which a thorough investigation of the whole of the interior can be made.

(d.) Special attention should be paid to the inspection of super-heaters, as with high pressure the plates may become dangerously weak and not give any sound to indicate their state when tested with the hammer; the plate should therefore be occasionally drilled. Drain pipes must be in all cases fitted to super-heaters in which a collection of water in the bottom is possible.

(e.) Super-heaters that can be shut off from the main boilers must be fitted with a Government lock-up safety valve of sufficient size, but the least size passed shall not be less than 2 inches diameter.

S
way
F
mul
pro
sup
are
S
of a
form
for
assu
the
the
of th

W
P
D
L
d
T
C
C
bolt
C
(b
plat

Se
exte
baff
the p
to g
Se
nect
prop
the r
fittin
the s
be p
vide
Se
fite
safet
any

(b
the s
stea
or st
failu
of st
Se
leas
mus
one
(b
mus
case
boile
sepa

Sec. 66. The areas of diagonal stays are found in the following way :

Find the area of a direct stay needed to support the surface, multiply this area by the length of the diagonal stay and divide the product by the length of a line drawn at right angles to the surface supported to the end of the diagonal stay, the quotient will be the area of the diagonal stay required.

Sec. 67. (a.) When the tops of combustion boxes or other parts of a boiler are supported by solid rectangular girders, the following formula, which is used by the Imperial Board of Trade, will be useful for finding the working pressure to be allowed on the girders, assuming that they are not subjected to a greater temperature than the ordinary heat of steam, and in case of combustion chambers, that the ends are fitted to the edges of the tube plate and the back plate of the combustion box :

$$\frac{C \times d^2 \times T}{(W-P) D \times L} = \text{Working pressure.}$$

W=Width of combustion box in inches.

P=Pitch of supporting bolts in inches.

D=Distance between the girders from centre to centre in inches.

L=Length of girder in feet.

d=Depth of girder in inches.

T=Thickness of girder in inches.

C=500 when the girder is fitted with one supporting bolt.

C=750 when the girder is fitted with two or three supporting bolts.

C=850 when the girder is fitted with four supporting bolts.

(b.) The working pressure for the supporting bolts and for the plate between them, shall be determined by the rule for ordinary stays.

Sec. 68. The flat ends of all boilers, as far as the steam space extends, and the ends of superheaters should be fitted with shield, or baffle plates, where exposed to the hot gases of the uptake, as all the plates subjected to the direct impact of heat or flame are liable to get injured unless covered with water.

Sec. 69. Donkey boilers that are in any way attached to, or connected with the main boilers, or with the machinery used for propelling the ship, must be inspected and fitted the same way as the main boilers, and have a water and steam gauge, and all other fittings complete, and as regards safety-valves, must comply with the same regulations as the main boilers, and no safety-valve shall be passed less than two inches diameter, except as hereinafter provided in the rules relating to the inspection of safety valves.

Sec. 70. (a.) No boiler or steam-chamber is to be so constructed, fitted or arranged as that the escape of steam from it through the safety-valve can be wholly or partially intercepted by the action of any other valve.

(b.) A stop valve must always be fitted between the boiler and the steam pipe, and when two or more boilers are connected with a steam receiver or superheater, between each boiler and superheater or steam receiver. The object of this is obvious, viz., to avoid the failure of all the boilers through the failure of one. The necks of stop valves should be as short as practicable.

Sec. 71. (a.) Each boiler must be fitted with glass water gauge, at least two test cocks, and steam gauge, that is to say, each boiler must be fitted with all the fittings as complete as if there were only one boiler.

(b.) Boilers that fire at both ends and those of unusual width, must have water gauges and test cocks at each end or side, as the case may be. When a steamer has more than one boiler, and those boilers are fitted with stop valves, each boiler must be treated as a separate one and have all the requisite fittings.

Sec. 72. Inspectors are to be most careful not to give any official sanction to any new arrangement or construction of marine steam boilers, without first obtaining the permission of the Chairman in writing, nor are they allowed to give any written approval of any invention or arrangement unless by direction of the Board, and whenever they know that any invention or new arrangement is to be fitted to a vessel that is intended to have a passenger certificate, they should, as soon as possible, obtain plans and submit the same to the Chairmau.

Sec. 73. When the longitudinal seams in cylindrical furnaces are not welded or made with a butt strap, as provided in section 52 of these regulations, the following constants will be substituted for 90,000 :

- (a.) Furnaces with butt joints and drilled rivet holes. { 90,000 where the longitudinal seams are double riveted and fitted with single butt straps; 80,000 where the longitudinal seams are single riveted and fitted with single butt straps; 90,000 where the longitudinal seams are single riveted and fitted with double butt straps.
- (b.) Furnaces with butt joints and punched rivet holes. { 85,000 where the longitudinal seams are double riveted and fitted with single butt straps; 75,000 where the longitudinal seams are single riveted and fitted with single butt straps; 85,000 where the longitudinal seams are single riveted and fitted with double butt straps.
- (c.) Furnaces with lap joints and drilled rivet holes. { 80,000 where the longitudinal seams are double riveted and bevelled; 75,000 where the longitudinal seams are double riveted and not bevelled; 70,000 where the longitudinal seams are single riveted and bevelled; 65,000 where the longitudinal seams are single riveted and not bevelled.
- (d.) Furnaces with lapped joints and punched rivet holes, { 75,000 where the longitudinal seams are double riveted and bevelled.
70,000 where the longitudinal seams are double riveted and not bevelled.
65,000 where the longitudinal seams are single riveted and bevelled.
60,000 where the longitudinal seams are single riveted and not bevelled.

Furnaces and Flues.

Sec. 74. (a.) The external working pressure to be allowed on plane circular steel furnaces and flues when subjected to such pressure, when the longitudinal joints are welded or made with a butt strap, shall be determined by the following formulæ :—

(b.) The product of 90,000 multiplied by the square of the thickness of the plate in inches, divided by the length of the flue, or furnace, in feet, plus 1, multiplied by the diameter in inches, will be the allowable working pressure per square inch in pounds; provided it does not exceed that found by the following formula :—

(c.) The product of 10,000 multiplied by the thickness of the plate in inches, divided by the diameter (outside) of the flue or furnace, in inches, will be the allowable working pressure per square inch in pounds.

Sec. 7
machine
found by
ends do
than $\frac{5}{16}$ i

(b.) W
should t
be neces

Sec.
practical
the ends
than $\frac{5}{16}$
following

Sec. 7
a series
accordin

Sec. 7
take the
pressure
test is ne
re-tested
and wate

Sec. 7
efficientl
it and ab
efficient 6

Sec. 8
have bee
static pr
that will
vessel to
be determ
riveting,

Sec. 8
vided by
until the
strength
from the

Sec. 8
and the
another,
hydrosta
outside a
pressure

Corrugated Steel Furnaces and Flues.

Sec. 75. (a.) Steel flue furnaces when new, corrugated, and machine made, and practically true circles, the working pressure is found by the following formula, provided that the plane parts at the ends do not exceed six inches in length, and the plates are not less than $\frac{1}{8}$ inch thick.

$$\frac{12,500 \times \text{thickness in inches}}{\text{Mean diameter in inches}} = \text{Working pressure per square inch.}$$

(b.) When the furnaces are riveted in two or more lengths the case should be submitted to the Chairman for consideration, as it may be necessary to make a reduction.

Corrugated Iron Furnaces.

Sec. 76. The working pressure for corrugated iron furnaces practically circular, and machine made, provided the plane parts at the ends do not exceed six inches in length and the plates are not less than $\frac{1}{8}$ inch thick, should not be greater than that found by the following formula:—

$$\frac{10,000 \times \text{thickness in inches.}}{\text{Mean diameter in inches}} = \text{Working pressure per square inch.}$$

Duties of Inspectors.

Sec. 77. Inspectors are to fix the working pressure of boilers by a series of calculations of the strength of the various parts, and according to the workmanship and material.

Sec. 78. Before testing a boiler the Inspector should examine it. take the necessary measurements and calculate what the working pressure should be, in accordance with these regulations. If the test is not satisfactory the defects must be made good and the boiler re-tested. This instruction applies to superheaters, steam chests and water jackets as well as boilers.

Sec. 79. If the boiler is too hot for the Inspector to examine it efficiently with safety and convenience he should decline to examine it and absolutely refuse to grant a certificate until he can make an efficient examination.

Sec. 80. Inspectors should see all new boilers and boilers that have been taken out of a ship for a thorough repair, tested by a hydrostatic pressure up to at least one and one half the working pressure that will be allowed previous to the boilers being placed in the vessel to test the workmanship, etc., but the working pressure is to be determined by the stay power, thickness of plates and strength of riveting, etc., and not by the hydrostatic test.

Sec. 81. The hydrostatic test should in no case exceed that provided by section 44 of these regulations, and it is never to be applied until the boiler has been opened up for examination and until the strength has been calculated from the necessary measurements taken from the boiler itself.

Sec. 82. When a boiler is partially inspected by one Inspector and the inspection is completed and the certificate to be granted by another, if the Inspector who witnesses the test of the boiler by the hydrostatic pressure has an opportunity of examining it inside and outside after the test, such Inspector shall determine the working pressure to be allowed on the boiler in question, taking care to inform

the owner or master, or maker or agent, and the Inspector who partially inspected it what working pressure should in his opinion be allowed on it, and the Inspector who partially inspected the boiler, should inform the Inspector who completes the inspection of all particulars of his inspection of the boiler.

Sec. 83. Cast iron must not be used for stays, and Inspectors should also discourage the use of cast iron for chocks and saddles for boilers. Particular attention should be paid to chocking and fastening boilers to the vessel.

Sec. 84. A pressure once allowed on the boiler of a passenger steamer is not, under any circumstances whatever, to be increased, unless the Inspector has previously written for and obtained the sanction of the Chairman. In cases where an Inspector is of opinion that an increased pressure may with safety be allowed he should communicate with the Inspector who last inspected the boiler, and if on learning the reason why the existing pressure was formerly allowed, the Inspector is still of opinion that it may be increased, he should communicate all the facts of the case to the Chairman, but as above stated the pressure should not in any case be increased until the question has been decided by the Chairman.

Sec. 85. In fixing the maximum working pressure on steam-boat boilers, Inspectors are to assume one hundred and twenty-five pounds to the square inch as the limit allowable for a new steel boiler forty-two inches in diameter, made in the best manner, of the best quality of steel plates, at least one quarter of an inch thick, with all the rivet holes drilled in place, the plates being then taken apart and the burrs removed, the longitudinal seams in the shell being fitted with double butt steel straps cut across the grain of the plate and each of at least five eighths the thickness of the plates they cover, and all the seams being at least double riveted and having at least seventy per cent. of the strength of the solid plate, and all the flat surfaces stayed in the best manner and all the seams double riveted, and they shall rate the working pressure of all steel boilers so made, whether of greater or less diameter according to their strength compared with this standard, and in all such cases the test applied shall exceed the working pressure allowed for such boilers in the ratio of one hundred and fifty pounds to one hundred pounds, using the water in such tests at a temperature not exceeding sixty degrees Fahrenheit, and all percentages added to the factor of safety for inferior workmanship or material, are to be deducted from that pressure.

Sec. 86. In fixing the maximum working pressure on steam boat boilers, Inspectors are to assume one hundred pounds to the square inch, as the limit allowable for a new boiler forty-two inches in diameter, made of the best refined iron, at least one quarter of an inch thick, in the best manner and of the quality herein required, and shall rate the working pressure of all iron boilers, whether of greater or less diameter, according to their strength compared with this standard, and in all such cases the test applied shall exceed the working pressure allowed, in the ratio of one hundred and fifty pounds to one hundred, using the water in such test at a temperature not exceeding sixty degrees Fahrenheit, and all percentages added to the factor of safety, for inferior workmanship or material, are to be deducted from that pressure.

Sec. 87. In the case of zig-zag riveting the strength through the plate diagonally between the rivets is equal to that horizontally between the rivets, when diagonal pitch = $\frac{1}{10}$ horizontal pitch + $\frac{1}{10}$ diameter of rivet.

Mode of

Sec.
do, and
water
pressur
one hu
water
Fahren
mental
well m
such te
hand-p
to be
Inspect
master
or boil
the boi
pressur
workin
herein
be not
the op

Sec.
hydros
coveri
cleane
so tha
bulke
plate a
master
are co

Sec.
defect
the Ins

Sec.
boilers
after s

Sec.
exami
to do
make

Sec.
condi
it nec
taken
and s
const
tests a

Sec
in Ca
distr
and s
free a

PART III.

*Rules for Inspection of Water Tube Boilers.***Mode of inspection of the water tube type of boiler known as the Roberts Safety Water Tube Boiler, or of similar type of boiler.**

Sec. 88. Any inspector may, whenever he deems it necessary so to do, and one inspector shall at least once in every year, subject the water tube boiler of every steam-boat to a test by hydrostatic pressure, in the ratio of two hundred pounds to the square inch, to one hundred pounds allowable as a working pressure, using the water in such test at a temperature not exceeding sixty degrees Fahrenheit, and shall satisfy himself by examination and experimental trials, under both steam and water tests, that such boiler is well made and of good and suitable materials. For the purposes of such tests the owner of the steam-boat shall provide the necessary hand-pump and apparatus, and fuel and other requisites, the same to be worked and operated by the crew of the vessel; and no Inspector of boilers and machinery shall make or deliver to the master or owner of any steam-boat fitted with water tube boiler or boilers, any certificate of inspection unless he has first subjected the boiler or boilers of such steam-boat to such tests, by hydrostatic pressure, and running under steam, to test both the boiler and the working of the feed pumps while running, and by examination as herein prescribed, the period of test while running under steam to be not less than one hour, but may be extended to a longer time at the option of the Inspector.

Sec. 89. Before a water tube boiler is subjected to a test by hydrostatic pressure it shall be opened up for inspection, the outer covering shall be removed and the outside and inside of the boiler cleaned, the furnace grates removed and the furnace swept out clean, so that satisfactory and efficient inspection may be made. When bulkheads are so placed as to prevent a close examination of the plate and tubes of the boiler, they shall be removed and the owner or master of the steam-boat shall see that the foregoing requirements are complied with before applying for inspection.

Sec. 90. In any case in which the test is not satisfactory, the defects shall be made good and the boiler re-tested satisfactorily to the Inspector before a certificate is granted.

Sec. 91. Inspectors are to fix the working pressure of water tube boilers by calculations of the strength of the several parts herein-after specified, and by tests of the whole as provided herein.

Sec. 92. If a water tube boiler is too hot for an Inspector to examine it efficiently with safety and convenience, he should decline to do so, and absolutely refuse to grant a certificate until he can make a satisfactory examination.

Sec. 93. In order to satisfy himself as to strength and internal condition of a water tube boiler, the Inspector may, should he deem it necessary, order holes to be cut in it, any sections or coils of pipes taken apart, and may also demand that such information by drawings and specifications of the several parts be furnished him of the construction, as will enable him to determine by calculations and tests and by examination their strength.

Sec. 94. During the construction of every water tube boiler made in Canada, the maker of such boiler shall notify the Inspector of the district in which it is being made, that it is open to his inspection, and shall at all times during such construction allow the Inspector free access to it.

Sec. 95. No part of a water tube boiler shall be made of boiler plate, whether iron or steel, which has not been stamped with the name or stamp of the maker thereof, and no certificate shall be granted with respect to any water tube boiler made partly of plate not so stamped, and before a certificate shall be granted with respect to any water tube boiler, a declaration on oath by the maker of the boiler, stating the name or stamp of the maker of the plates, their quality and the quality of all pipes and materials used in the construction of the boiler, and stating the quality of the workmanship, shall be furnished the Inspector; such oath may be taken before any justice of the peace in Canada, or before a notary public and certified under his official seal if taken out of Canada: Provided that in any case such declaration on oath by the maker of the boiler cannot be obtained from any cause deemed sufficient by the Inspector, the affidavit of two practical water tube boiler makers who have examined the boiler and reported upon the quality of the materials in it, and its workmanship and strength, shall if satisfactory to the Inspector be deemed sufficient in lieu of such declaration by the maker of the boiler.

Sec. 96. To prevent questions arising after a water tube boiler is commenced, particulars of its construction by drawings or specifications should be furnished the Inspector by the maker or contractor for his approval, the Inspector having received such drawings and specifications, and not disapproving of them, will be careful to see that they are followed in construction, or to make deductions to the working pressure if not followed; this regulation will also apply to boilers undergoing alterations.

Sec. 97. No water tube boiler or pipe in connection therewith shall be approved which is made in whole or in part of bad or faulty material, or bad workmanship, or is unsafe in its form, or from age, or from use, or from any other cause.

Sec. 98. Inspectors should see all new water tube boilers, and water tube boilers that have been taken out of a ship for thorough repair, tested by hydraulic pressure up to at least twice the working pressure that will be allowed previous to the boiler being placed in the vessel, to test the workmanship and materials, but the working pressure is not to be determined by the test alone, as the stay power, thickness of plate and tubes, and the strength and workmanship are all to be considered.

Sec. 99. The hydraulic test should not exceed twice the working pressure allowed, and it is never to be applied until the boiler has been opened up for examination, and the strength of the parts has been decided on, from the measurements and examination of those parts of the boiler.

Sec. 100. When a water tube boiler is partially inspected by one Inspector, and the inspection is completed and the certificate to be granted by another Inspector, if the Inspector who witnesses the tests of the boiler by hydrostatic pressure, and while running under steam, has an opportunity of examining the boiler inside and outside after the tests, such Inspector shall determine the working pressure to be allowed on the boiler, taking care to inform the owners or maker, or master or agents, and the Inspector who partially inspected it, what working pressure should in his opinion be allowed, and the Inspector who partially inspected the boiler should inform the Inspector who completes the inspection of all particulars of his inspection of the boiler.

Sec. 101. Cast iron must not be used for stays, pipes or elbows in water tube boilers; Inspectors should also discourage the use of cast iron for chocks and saddles for boilers; particular attention should be

paid to shifting metal,

Sec. under provision of the is of be all inspect pressur that it case t should deci le

Sec. tube streng Inspe the wo

Sec. unless workm to give until a

Sec. allow section stress welded the are of the

Sec. the fol

Wh the ar found

d =
T =
S =
C =
(a.
or h
Wate
into
head
(b
wher
Insp
then
scre
from
to th

be made of boiler stamped with the certificate shall be made partly of plate stamped with respect to the maker of the plates, their use in the construction of the workmanship, taken before any public and certified provided that in any boiler cannot be the Inspector, the to have examined materials in it, and its the Inspector be the maker of the

water tube boiler is drawings or specifications or contractor drawings and be careful to see reductions to the will also apply to

therewith shall of bad or faulty workmanship, or from age,

boilers, and up for thorough inspection of the working parts being placed in at the working pressure, as the stay and workman-

the working parts of the boiler has the parts has the attention of those

pected by one certificate to be witnesses the running under the and outside working pressure the owners or who partially in be allowed. should inform particulars of his

or elbows in the use of cast iron should be

paid to chocking and fastening boilers to vessels to guard against shifting or breaking loose, and all pipes to be of the best quality of metal, lapwelded or solid drawn.

Sec. 102. A pressure once allowed on a water tube boiler is not, under any circumstances, to be increased, unless the Inspector has previously written for and obtained the sanction of the Chairman of the Board of Steam-boat Inspection. In cases where an Inspector is of opinion that an increased working pressure may with safety be allowed he should communicate with the Inspector who last inspected the boiler, and if on learning the reason why the existing pressure was formerly allowed, the Inspector is still of the opinion that it may be increased, he should communicate all the facts of the case to the Chairman, but as above stated the working pressure should not in any case be increased until the question has been decided by the Chairman.

Sec. 103. In the event of any novelty in construction of a water tube boiler, or any departure from the practice of staying and strengthening as prescribed in these regulations and rules, the Inspector shall report full particulars to the Chairman before fixing the working pressure.

Sec. 104. An Inspector shall not declare a water tube boiler safe unless he is fully informed as to its construction and material and workmanship; he should therefore be very careful when he proposes to give a certificate for a boiler that he is not called in to inspect until after it is completed and fitted in the ship.

Sec. 105. In the case of new water tube boilers the Inspector may allow a stress not exceeding 5,000 pounds per square inch of net section on solid iron screw stays supporting flat surfaces, but the stress should not exceed 4,000 pounds when the stays have been welded, where the head of drum is held by one stay in the centre, the area to be supported by it will be one quarter of the whole area of the head, measuring from inside of drum.

Sec. 106. The pressure on plate forming flat surfaces is found by the following formula:—

$$\frac{C \times (T + 1)^2}{S - 6} = \text{Working pressure per square inch.}$$

When the head of drum is supported by one stay in the centre the area of flat surface supported and the working pressure will be found by the formula:

$$\frac{C \times (T + 1)^2}{\left(\frac{d}{2} - 1\right)^2 - 6} = \text{Working pressure.}$$

d = Inside diameter of drum head in inches.

T = Thickness of plate in sixteenths of an inch.

S = Surface supported in square inches.

C = Constant as follows:

(a.) C = 80 when the plates are exposed to the impact of heat, flame or hot gases, and the water and steam (as in the Roberts Safety Water Pipe Boiler) in contact with the plates, and the stays screwed into the plates, fitted with nuts, or well riveted over with a good head.

(b.) When the riveted ends of the screw stays are much worn, or when the ends are burned, the constants should be reduced, but the Inspector must act according to the circumstances that present themselves at the time of the inspection, as when the ends of the screw stays are found in this condition the constant may be reduced from 80 to 36. In doubtful cases the Inspector should refer the case to the Chairman.

Sec. 107. With regard to the inspection generally of the Roberts Safety Water Tube Boiler, or of boilers of a similar type:—

The boiler shall be open to inspection during construction, the Inspector to satisfy himself that, in regard to all boilers constructed of this type made after the first day of February, 1891, the quality of the plate or material of which the drum is made is of the "best quality," and stamped with the name or stamp of the manufacturer thereof, and if of steel the tensile strength to be between 57,000 pounds and 64,000 pounds, and with not less than 25 per cent. elongation, and the tests for plates (applicable when the drum is riveted longitudinally) and for stays to be similar to tests required in section 36 of the foregoing "Rules for inspection of boilers of steam-boats."

(a) The constant for calculating the working pressure to be allowed on the drum if of iron plates to be 24,000 pounds per square inch of sectional area, and if of steel plates 30,000 pounds, due regard being had to percentage of seams if riveted, and to percentage of plate left by line of holes where the water tubes are attached, using a factor of not less than 5, with additions as provided in the foregoing "Rules for inspection of boilers of steam-boats."

Sec. 108. The thickness of plate in drums of water tube boilers of less than ten inches diameter to be not less than three eighths of an inch, and of ten inches diameter and up to fourteen inches diameter to be not less than half an inch thick, and the drum heads to be in no case less than half-inch thickness, and after being flanged, if of steel plate, to be annealed.

Sec. 109. The safety valves to be placed one on the steam pipe near the drum, and one on the drum, the number and dimensions of safety valves will be the same as provided by "Rules relating to the inspection of safety valves."

Passed by Board 30th December, 1890.

W. J. MENEILLEY,

Chairman Board of S.-B. I.

PART IV.

Rules Relating to the Inspection of Safety Valves. As Provided by Sec. 1 of the Act 53 Vic., Chap 17, Intituled "An Act to Amend the Steam-boat Inspection Act, Chap. 78, of the Revised Statutes."

Sec. 110. (a.) After the following rules come into operation, every boiler made or placed on board a steam-boat shall be fitted with two or more lock-up safety valves of a construction approved by the Board of Steam-boat Inspection, or by the Chairman, if the Board is not then in session; the aggregate area of said lock-up safety valves shall not be less than that given in the following tables opposite the boiler pressure intended, the safety valves should be upon the boiler, or as near the boiler as practicable without pipes, cocks, valves or other possible obstructions between the safety valves and the boiler.

Every Inspector, when inspecting, visiting or examining the boiler or machinery of any steam-boat, shall satisfy himself that the safety valves attached thereto are of suitable dimensions, sufficient in number, well managed and in good working order, and only loaded so as to open at or below the certified working pressure; and he may, if he thinks proper, order and cause two or more of such safety valves which together shall be of sufficient dimensions to discharge all the steam the boiler can generate, and of such construction as he approves, to be locked up and taken wholly away from the control of the engineer when the steam is up; but the engineer shall have

access to the safety valves when the steam is not up, and shall see that they are kept in working order, and the master of the steam-boat shall see that the engineer has access to them for that purpose, and keeps them in proper working order :

The cocks and valves attached to the boilers shall be substantially made, and in no case shall they be attached to the boilers by screwing into the plate, unless, as an additional security, bolted flanges are used in addition to such attachment :

No valve, under any circumstance, shall, at any time, be so loaded or so managed in any way, as to subject a boiler to a greater pressure than that allowed by the Inspector at the then last inspection thereof :

Every safety valve made or placed on board of a steam-boat and attached to a boiler shall have a lift equal to at least one-fourth of its diameter ; the openings for the passage of steam to and from the valve shall each have an area not less than the area of the valve, as shall also the waste steam pipe, and the valve box shall have a waste water pipe ; if the lever of a lever safety valve is not bushed with brass the pin shall be of brass,—iron and iron working together shall not be allowed ; every such safety valve shall be fitted with a lifting gear so that it can be worked by hand, either from the engine room or the fire hold, or by the master or person in charge on deck ;

(b.) Safety valves should not be passed of a diameter less than two inches, except in the case of small boilers where the area of grate surface is less than fifteen square feet, when safety valves of less diameter may be used, but in no case shall their diameter be less than one inch, and provided they are of approved construction, and the proportion of area of safety valve to area of grate be complied with as given by the tables of safety valve areas.

(c.) The grate area shall be ascertained by measuring the length of the grate from the inner edge of the dead plate to the front of the bridge and the width from side to side of the furnace on top of the bars at the middle of their length.

(d.) The safety valve should be tested (by the Inspector) on new boilers, or on other boilers if he wishes to test their efficiency, under full steam and full fires, for at least 15 minutes with the feed water shut off and stop valve closed, if the accumulation of pressure exceed 10 per cent. of the loaded pressure, he should not issue a certificate without reporting to the Chairman full particulars of the test, and the strength pressure of the boiler with sketch of safety valve, and in no case is an Inspector to give a certificate for safety valves, unless he has examined them and is acquainted with the details of their construction.

Sec. 111. (a.) Inspectors are instructed that in all new boilers and whenever alterations can be easily made, the valve chest should be placed directly on the boiler, and the neck or part between the chest and the flange which bolts on to the boiler should be as short as possible.

(b.) In any case in which an Inspector is of opinion that it is positively dangerous to have a length of pipe between the boilers and the safety valve chest, he shall at once insist on the requisite alterations being made before granting a certificate.

(d.) If lever safety valves are used the distance between the centre of the valve and the centre of the fulcrum should not be less than the diameter of the valve.

(e.) Safety valves must be placed in convenient and accessible places, that their adjustment and examination may be readily and efficiently made. The Inspector in his examination of the boilers and machinery is particularly to direct his attention to the safety valves,

and whenever he considers it necessary he is to satisfy himself as to the pressure on the boiler by actual trial. The Inspector is to examine the safety valves, weights, and springs at every inspection.

(f.) The valve seats should be secured so that they cannot lift with the valve.

(g.) The spindle should be so attached to the valve, that when the spindle is lifted, the valve will also lift.

(h.) The size of the steel of which the spring is made in spring safety valves is found by the following formula taken from the Imperial Board of Trade Rules :—

$$\sqrt[3]{\frac{S \times D}{c}} = d.$$

$c = 8,000$ for round steel.

$c = 11,000$ for square steel.

$S =$ The load on the springs in pounds.

$D =$ The diameter of the spring (from centre to centre of the wire in inches).

$d =$ diameter, or side of square, of the wire in inches.

The spring should be protected from the steam and impurities issuing from the boiler, and in case of the spring breaking means be provided to keep it in position on the valve.

(i.) A standard spring if made of the best square cast steel contains $\cdot 25$ of a square inch, the inside diameter is two inches, and the outside diameter is three inches, it has thirteen complete coils with the ends and is $11\frac{1}{2}$ inches long. The working load is assumed at 600 pounds, one-sixth of its breaking load when hardened to a temper, just sufficient to break it, at which load it should deflect just one inch.

(j.) To find the sectional area of any other spring the pressure or weight on the valve being given :—

600 : 700 : $\cdot 25$: : $\cdot 29 =$ sectional area of spring at 700 pounds load. The other dimensions of the spring would be in like proportion, the number of coils thirteen being constant.

SAFETY-VALVE AREAS.

Boiler Pressure.	Area of Valve per square foot of Fire-grate.	Boiler Pressure.	Area of Valve per square foot of Fire-grate.
lbs.	sq. in.	lbs.	sq. in.
15	1·250	65	·468
16	1·209	66	·462
17	1·171	67	·457
18	1·136	68	·451
19	1·102	69	·446
20	1·071	70	·441
21	1·041	71	·436
22	1·013	72	·431
23	·986	73	·426
24	·961	74	·421
25	·937	75	·416
26	·914	76	·412
27	·892	77	·407
28	·872	78	·403
29	·852	79	·398
30	·833	80	·394
31	·815	81	·390
32	·797	82	·386
33	·781	83	·382
34	·765	84	·378
35	·750	85	·375
36	·735	86	·371
37	·721	87	·367
38	·707	88	·364
39	·694	89	·360
40	·681	90	·357
41	·669	91	·353
42	·657	92	·350
43	·646	93	·347
44	·635	94	·344
45	·625	95	·340
46	·614	96	·337
47	·604	97	·334
48	·595	98	·331
49	·585	99	·328
50	·576	100	·326
51	·568	101	·323
52	·559	102	·320
53	·551	103	·317
54	·543	104	·315
55	·535	105	·312
56	·528	106	·309
57	·520	107	·307
58	·513	108	·304
59	·506	109	·302
60	·500	110	·300
61	·493	111	·297
62	·487	112	·295
63	·480	113	·292
64	·474	114	·290

SAFETY-VALVE AREAS—Continued.

Boiler Pressure.	Area of Valve per square foot of Fire-grate.	Boiler Pressure.	Area of Valve per square foot of Fire-grate.
lbs.	sq. in.	lbs.	sq. in.
115	.288	158	.216
116	.286	159	.215
117	.284	160	.214
118	.281	161	.213
119	.279	162	.211
120	.277	163	.210
121	.275	164	.209
122	.273	165	.208
123	.271	166	.207
124	.269	167	.206
125	.267	168	.204
126	.265	169	.203
127	.264	170	.202
128	.262	171	.201
129	.260	172	.200
130	.258	173	.199
131	.256	174	.198
132	.255	175	.197
133	.253	176	.196
134	.251	177	.195
135	.250	178	.194
136	.248	179	.193
137	.246	180	.192
138	.245	181	.191
139	.243	182	.190
140	.241	183	.189
141	.240	184	.188
142	.238	185	.187
143	.237	186	.186
144	.235	187	.185
145	.234	188	.184
146	.232	189	.183
147	.231	190	.182
148	.230	191	.181
149	.228	192	.181
150	.227	193	.180
151	.225	194	.179
152	.224	195	.178
153	.223	196	.177
154	.221	197	.176
155	.220	198	.176
156	.219	199	.175
157	.218	200	.174

$\frac{37.5}{\text{Gross pressure}} = \text{Square inch of safety valve per square foot of grate.}$

Sec
of th
the l
as p
when
fallen
(b.
necti
found
cond
inspe
(c.
final
the l
boile
enda
at w
boile
make
revok
(d.
Depa
boile
to ab
comp
(e.
once
that
suffic
also
order
these
(f.
along

Sec
Stear
If pra
quick
(b.
gentl
(c.
(d.
gangu
(e.
alwa
(f.
ashes
(g.
let th
hot a
(h
incr
appr
(i.
free
press
sary
safet

PART V.

Duties and Liabilities of Engineers.

Sec. 112. (a.) Engineers are required in all cases upon stopping of the engine to open the safety valves, so as to keep the steam in the boiler below the limit allowed by the Inspector's certificate as prescribed by law, to open the doors or close the dampers, and when from accident or other cause, the water in the boiler has fallen below the point of safety, to put out the fires immediately.

(b.) Engineers shall keep the fire pump and hose and their connections in perfect condition ready for immediate use, and when found unfit for use from age or other cause, shall report their condition to the Inspector of Hulls by whom the steamer was last inspected.

(c.) Engineers when laying up a steamer in the fall, or when finally leaving her, are required to report to the owner and also to the Inspector of the nearest district any defects of, or injury to, the boilers and machinery by which the safety of the same may be endangered. They shall also report to the Inspector of the district at which the steamer next arrives, any accident happening to the boilers or machinery during the trip, and in case of omission to make such report, the license of the engineer so omitting shall be revoked.

(d.) The Chief Engineer of a steamer is held accountable by the Department of Marine for the proper care and management of the boilers and machinery under his charge. He is, therefore, in no case to absent himself from the vessel while on her regular trips, unless a competent substitute be provided to fill his place during his absence.

(e.) Engineers on first taking charge of a steamer, and at least once a year thereafter, shall satisfy themselves by close examination that the braces, stays and pins of the boiler are in good order, and sufficient for the strain to which they may be subjected; they shall also satisfy themselves that the safety valves are in good working order and sufficient for the requirements of sections 63 and 110 of these regulations.

(f.) Engineers are to exhibit their certificates in the engine room along with a copy of these regulations when required to do so.

Management of Boilers.

Sec. 113. (a.) Getting up steam.—Warm the boiler gradually. Steam should not be raised from cold water in less than four hours. If practicable light the fires over night. By getting up steam too quickly, the boiler will soon be destroyed.

(b.) Firing.—Fire regularly. Keep the sides up, and use the slice gently and as seldom as possible.

(c.) Feed water.—Let the feed be regular and constant.

(d.) Glass gauge and try cocks.—Keep the glass free and try the gauge cocks every fifteen minutes.

(e.) Safety valves.—Lift each safety valve at least once a day, and always before getting up steam.

(f.) Low water.—Put out the fires by drawing them or throwing ashes on them. Never use water. Low water should never occur.

(g.) Blowing off the boiler.—Do not blow off by steam pressure; let the water run off if possible. See that the fires are all out and hot ashes removed.

(h.) Boiler Purgers.—Never use any compositions to keep down incrustation, or oil or other impurities to remove it without the approval of the Chairman.

(i.) General Rules.—Keep the boiler clean inside and outside and free from leak. Never throw water in the furnace. Under high pressure, raise the safety valve gently. Lower the fires, or, if necessary stop the engine (if in the master's opinion it can be done with safety to the vessel) when foaming to find a water level.

Valve
are
te.

grate.

PART VI.

Regulations Relating to the Examination of Engineers.

Fourth Class Engineers.

1. No person shall be intitled to a fourth class engineer's certificate unless he has the following qualifications, that is to say :—

(a.) He shall be over twenty-one years of age.

(b.) He shall have served an apprenticeship of not less than thirty-six months in a steam engine shop, and been employed on the making and repairing of steam engines—or if he has not served such apprenticeship, he shall have been employed for not less than thirty-six months as a journeyman mechanic in some workshop, on the making and repairing of steam engines ;—or

(c.) He shall have served at least thirty-six months in an engine room of a steamboat as engineer on the watch ;—or

(d.) He shall have served not less than thirty-six months as oiler on the watch in the engine room of a steamer of not less than thirty nominal horse power ;—or

(e.) He shall have served not less than forty-eight months as fireman on the watch in the firehold of a steamboat of not less than thirty nominal horse power ;—

(f.) And in any of the above mentioned cases of service, twelve (12) months' service in a boiler shop on the making and repairing of steam boilers may be accepted in lieu of twelve months of the service named.

(g.) Service in the dual capacity of engineer and fireman, or oiler and fireman, will only be accepted as fireman service for fourth and not for any other class of engineer.

(h.) He shall be able to read, and write a legible hand.

(i.) He shall understand the construction and operation of the feed-water pump, water gauges and safety valves : he shall know when a boiler is foaming, and how to stop the foaming, and also the dangers resulting from neglect to keep a boiler clean, and the usual methods of cleaning it.

Third Class Engineers.

2. No person shall be entitled to a third class engineer's certificate unless he has the following qualifications, that is to say :—

(a.) He shall be over twenty-one (21) years of age.

(b.) He shall have served an apprenticeship of at least thirty-six months in a steam engine shop employed in the making and repairing of steam engines ;—or if he has not served such apprenticeship, he shall have been employed at least thirty-six months as a journeyman mechanic in some workshop, in the making and repairing of steam engines, and in either case shall also have served twelve months in the engine room of a steamboat, as engineer on the watch ;—or

(c.) He shall have served forty-eight months at least in the engine room of a steamboat as an engineer on the watch ;—

(d.) He shall be able to give a description of boilers and the methods of staying them, and shall know the means of repairing them, the method of lining the engine, setting the eccentrics and adjusting the valves, the cause of any derangement and the means of remedying it ;—

(e.) He shall be able to read and shall write a legible hand, and understand the first five rules of arithmetic.

Second Class Engineers.

A second class engineer shall have qualifications as follows, that is to say:—

(a.) He shall be over twenty-one years of age.

(b.) He must have served an apprenticeship of not less than thirty-six months in a steam engine shop, and have been employed on the making and repairing of steam engines;—or if he has not served such an apprenticeship he must prove that for not less than thirty-six months he has been employed as a journeyman mechanic, in some workshop, on the making or repairing of steam engines,* in either case he must also have served at least twelve months in the engine room of a steamboat of not less than thirty nominal horse power, as an engineer on the watch;—or

(c.) He must have served at least forty-eight months in the engine room of a steamboat as engineer on the watch, at least twenty-four months of which shall have been on a steamboat of not less than thirty nominal horse power.

(d.) He must be able to give a description of boilers, and the methods of staying them, together with the use and management of the different cocks, valves, pipes and connections.

(e.) He must understand how to correct defects from accident, decay, etc., and the means of repairing such defects.

(f.) He must understand the use of the barometer, thermometer, salinometer, and the principles on which they are constructed.

(g.) He must state the causes, effects and usual remedies for incrustation and corrosion.

(h.) He must be able to state how a temporary or permanent repair could be effected in case of derangement of a part of the machinery.

(i.) He must write a legible hand, and understand the first five rules of arithmetic, and decimals, and their application to questions about consumption of stores, and full capacities of tanks and bunkers, the duty of pumps, and the direct strains in engines and collers.

(j.) He must be able to pass a creditable examination as to the various constructions of paddle and screw engines in general use; as to the details of the various working parts, external and internal, and the use of each part.

First Class Engineer.

4. A candidate for first class engineer's certificate must be at least twenty-two years of age.

(a.) In addition to the qualifications required for a second class engineer, he must have had at least twelve months' service in a grade not lower than second engineer on watch in the engine room, in a steamboat or in steamboats of one hundred nominal horse power or over, during which time he must have held a second class engineer's certificate of competency.

(b.) He shall be competent to calculate the thickness of plates for a boiler of given dimensions to carry a fixed pressure of steam per square inch, also the pressure a boiler may be allowed as a working pressure, its dimensions, stays and other parts, method of construction and thickness of plates being given.

(c.) He shall be able to calculate the direct strain, the twisting strain, and the bending strain in rectangular bars, and in round bars with given loads. The required capacity of the feed pump, and the area of the safety valves for a boiler of given dimensions, and the power of the engine from an indicator diagram of its work.

* No period of service in a drawing office of over six months can be allowed to count for workshop service.

(d.) He shall know the relative volumes of steam at different temperatures and pressures, the chemical constituents of coal, and the quantity of air required for its combustion.

(e) He must have a knowledge of surface condensation, superheating and the working of steam expansively.

(f.) He must be able to explain the operations of the engine, and to make a working drawing of any of its parts.

(g.) His knowledge of arithmetic must include the extraction of the square root, and the mensuration of superficies and solids.

Applications for examination are to be made to the Board of Steam-boat Inspection, or to the Inspector of the division where the candidate resides, the application to be made on forms furnished for that purpose by the Inspector, and to be accompanied with proofs of service, and testimonials as to sobriety, experience and ability, and to character, and to general good conduct for at least the twelve months immediately preceding the date of application to be examined. If the service has been on shore the testimonials must be signed by an employer; if at sea by the master and chief engineer; if not so signed satisfactory reasons must be given the examiner, who will not accept proofs of service or testimonials which are not entirely satisfactory.

Engineers who from any cause have had their certificates cancelled will be re-examined before they are again allowed to hold a certificate of the same grade. Upon their passing the examination a new certificate will be issued to them. The Minister of Marine may, however, in special cases, upon report of the Board of Steam-boat Inspection, if the circumstances warrant it, dispense with the re-examination.

Any engineer who held an engineer's certificate previous to the year 1886, of the first, second or third class, may receive a certificate from the Minister of the same grade, on passing an examination similar to his first examination before the Board of Steamboat Inspection, if the said Board, or the Chairman thereof, is satisfied that his character, habits of life, knowledge and experience in the duties of an engineer, are such as to qualify him to be such engineer, and provided that the said Board, or the Chairman thereof, so reports to the Minister, specifying the grade of certificate he is to receive, and for such certificate he shall pay a fee of \$5.

SERVICE REQUIRED FOR SECOND OR FIRST-CLASS ENGINEERS' CERTIFICATES VALID IN THE UNITED KINGDOM.

Engineers possessing first and second-class Canadian certificates, who passed examinations equal to the examinations at present in force in the United Kingdom, and who are desirous of exchanging their certificates for the same grade certificate valid in the United Kingdom, may apply to the Chairman or an Inspector for examination in regard to sea service, sobriety, character, colour tests, ability and hearing. If successful in passing the examination, a certificate valid in the United Kingdom may be issued free of charge.

Candidates for second or first class Canadian (Engineers') certificates valid in the United Kingdom, will be required to pass examinations equal to the examinations in the United Kingdom.

The service required, proof of which the examination papers of the applicant must exhibit, is as follows:—

Second Class Engineers' Certificates Valid in the United Kingdom.

1. { 36 months' workshop service making and repairing steam engines, together with—
12 months service as engineer on the watch in the foreign trade,—or
2. { 36 months workshop service making and repairing steam engines, together with—
18 months' service as engineer on the watch in the coasting trade,—or
3. { 36 months' workshop service making and repairing steam engines, together with—
18 months' service as engineer on the watch in the lake or river trade, and
3 months' service as engineer on the watch in actual sea service,—or
4. { 48 months' service as engineer on the watch in the foreign trade, or
5. { 72 months' service as engineer on the watch in the coasting trade, or
6. { 90 months' service as engineer on the watch in the lake or river trade, with
3 months' service as engineer on the watch in actual sea service.

First Class Engineer Certificates Valid in the United Kingdom.

1. In addition to the qualifications required for a second class engineer, the candidate must have had at least 12 months' sea service as engineer on the watch in the engine room of a steamship of not less than 100 nominal horse power, during which time he must have been in possession of a second class engineer's certificate of competency;
2. Or he must have served at least 18 months as engineer on the watch in a steamship engaged in the coasting trade of not less than 100 nominal horse power and have been possessed of a second class engineer's certificate of competency during that time;
3. Or he must have served 12 months as first, or only engineer on a lake or river steamer having an aggregate piston area of not less than 2,000 circular inches, in addition to which he must have had at least 6 months' actual service at sea as engineer on the watch, during all of which time he must have been in possession of a second class engineer's certificate of competency.

Interpretation.

"Lake or river service" refers to service on the inland waters which must have been performed in a capacity not lower than 3rd engineer on a steamer having an aggregate piston area of not less than 2,000 circular inches, 2 months of such service being considered only as equivalent to one month actual sea service.

"Coasting trade" refers to service in steamships plying between any port or place in Canada, and any other port or place in Canada, not being a port or place on the inland waters. Service in the coasting trade must amount to half as much again as service in the foreign trade.

"Workshop service" refers to an apprenticeship to an engineer, or as a journeyman mechanic employed in a factory, or workshop, making and repairing steam engines.

"Engineer on the watch" refers to the actual charge of the propelling engines, responsible for the bells, and in a capacity which affords opportunity of obtaining practical experience as an engineer. Service in the capacity of greaser or fireman will not be accepted.

"Sea service" or "foreign trade" refers to service in steamships engaged in the foreign sea trade, and plying between some port or place in the Dominion and some port or place outside the Dominion, not being a port or place on any of the inland waters.

PART VII.

Inspection of Hulls and Equipment of Steamboats Carrying Passengers.

Sec. 1. Inspectors of Hulls, before granting a passenger certificate, must be satisfied that the following particulars have been complied with, in accordance with the requirements of the Act relating to steamboat inspection.

(a.) That the hull of the vessel is sufficient for the service intended, and in good condition.

(b.) That the boats, life-preservers, buoys, lights, signals and compasses are in good condition, and the certificates of the master and mate, or mates, are such as are required by the said Act.

(c.) The time (if less than 12 months) for which the said hull will be deemed sufficient.

(d.) The limits (if any) beyond which, as regards the hull and equipments, the vessel is, in the Inspector's judgment, not fit to ply.

(e.) The number of passengers besides the crew, the vessel is allowed to carry, distinguishing, if necessary, between the respective numbers to be carried on the main deck and upper deck.

Sec. 2. (a.) Inspectors shall make their inspections when the owner, or master, and engineer of the vessel are present, if possible. Repairs can then be required, and defects can be pointed out to the proper persons without incurring delay. If these persons are not present, the Inspectors will make their inspection without them.

(b.) In order to prevent any mistakes as to the nature and extent of repairs required by the Inspectors, whenever they can not give a certificate until the repairs are effected or alterations made, a written statement of the defects to be remedied or alterations required, shall in all cases, be handed to the owner or master of the vessel, whether such statement is applied for by him or not, a copy of which should be always taken and transferred to the office press letter book.

(c.) If any difference of opinion arises between the Inspector and the owner or master, the facts should at once be submitted to the Chairman of the Board of Steamboat Inspection for consideration, and for reference to the Minister of Marine and Fisheries, when necessary.

Sec. 3. If a vessel usually plying in one district, is taken to another district to be inspected, the Inspector in the latter district shall not give a certificate without first communicating with the Inspector for the former district; nor, if there is any difference of opinion, without referring the question to the Chairman aforesaid for decision.

Sec. 4. It is the duty of the Inspector of Hulls to satisfy himself personally upon every detail of the inspection of a vessel, and not to trust to any certificate, or other document given by any person not responsible to his Department, who will hold him responsible to the

fullest extent for the performance of the duty entrusted to him, and will support him in any reasonable step he may think necessary, in order to the fullest performance of his duty.

Sec. 5. In case the Inspector has reason to believe that the hull or equipment is not fit for so long a time as twelve months, he is to grant his certificate for such shorter period as he may deem proper, informing the owners of his reasons for so doing.

Sec. 6. It is most desirable that an Inspector should complete the inspection of a vessel in every detail when he has commenced it; and, if possible, arrangements should always be made with the owners to secure this. Delays and inconveniences may be prevented, if notice is given by owners when the vessel is ready for inspection, and her equipment in place on board. An Inspector should not sign a certificate for any detail which he has not inspected, and for which he is not prepared to hold himself personally responsible.

Sec. 7. Every person who knowingly and wilfully makes or assists in making, or procures to be made, a false or fraudulent certificate with respect to any steamboat, or who forges or assists in forging, or procures to be forged, fraudulently alters, or assists in fraudulently altering any certificate required by the Steamboat Inspection Act, or any words or figures in any such certificate or any such certificate or any signatures thereto, is guilty of a misdemeanor.

Sec. 8. A certificate for twelve months shall not be granted, whenever the Inspector has any doubts whatever, as to the efficiency of any part of the vessel or equipment for such period.

Sec. 9. Inspectors shall determine whether hulls of passenger steamers are in good condition and fit for the service for which they are intended; and shall examine the hulls outside and inside, once a year, if possible, or oftener, and at such a time as is most convenient to the owner.

Sec. 10. New steam-boats should be inspected before painting or completion, but any such inspection is not to interfere with the complete inspection of hull and equipment, after completion, the object being to form an opinion of the workmanship, material and construction.

Sec. 11. When a steam-boat which has been inspected for a passenger certificate, is not in every respect in good condition, although the defects may not be sufficient to warrant the withholding the certificate, and although the vessel may be practically fit for the service intended, the Inspector should, when he grants the certificate, forward to the Chairman aforesaid a report showing the nature of the defects in question.

Sec. 12. For examining the internal parts of a passenger steam-boat, the inspector shall if he considers it necessary, have parts of the ceiling removed, in order that he may ascertain the condition of the hull, frames, floors, &c., particularly in the engine room and boiler space, and also in the coal bunkers, they being empty.

Sec. 13. The date of the last inspection shall be entered in an office inspection book with particulars of the condition of the hull at that time, with approximate sketches of the midship section, showing the form, build, and dimensions of the vessel, and parts, sufficiently to judge of her shape and strength. Any question or doubt as to the strength of the vessel for the route on which she is placed, should be referred to the Chairman aforesaid.

Sec. 14. The height of the coamings around all openings in main deck, and the means provided for securely protecting or fastening down all skylights, bunker openings, &c., are important items to be

noticed by the Inspector in steam-boats subject to heavy seas. All gangways and openings, on, or below weather deck, should be fitted with covers in such a manner that they can be quickly and efficiently secured. Hatch covers should be provided with means for effectually securing them down. Grating and hatch covers must be kept and secured in a suitable place, at all times accessible, and near to the openings for which they are intended.

Sec. 15. All boats should be hung on davits and kept ready for service at any moment. Inspectors should see that in all boats the full complement of oars is provided, that each boat has two plugs to each plug hole, attached with lanyards or chains, and one set and a half of thole pins or crutches attached to the boat by sound lanyards, a bailer, a rudder and tiller or yoke and yoke-lines; a painter of sufficient length and a boat hook. The rudder and bailer shall be attached to the boats by sufficient long lanyards and ready for use; means for speedily detaching the boats from the lower blocks of the davit tackles should be insisted upon. An ordinary fixed hook in the lower block shipped into fixed eye in the boat should not be allowed.

Sec. 16. Inspectors should see that the davits are strong enough, that they are so spaced that the boat can be swung out without unnecessary labour; that the boat chocks can be expeditiously removed, and that the boats will not foul the ship's sides when lowering, when the ship has no list. The whole of the tackling, including the davits, equipment and crew, falls, blocks, eye bolts and rings, &c., shall be of sufficient strength to lower the boat with its full equipment and crew on board. The davit tackle falls must be long enough to lower the boat into the water, when the vessel is light. Life lines should be fitted to the davits long enough to reach the water when the vessel is light, and allowance made for the extreme roll of the vessel.

Sec. 17. Inspectors will refuse a certificate in cases in which these instructions are not carried out, but it is to be left to the owners of passenger steam-boats to furnish such methods as they please for lowering boats so long as the intention of the Act is complied with. Any unusual or doubtful method of lowering boats must be submitted to the Board of Steam-boat Inspection for its consideration and approval before it is passed. All boats should be lowered into the water at every inspection.

Sec. 18. Life-buoys with lines attached should be secured by a toggle or becket, or any other similar method, so that they may be quickly released. They must not be lashed or seized to the rail or any other part of the vessel, but must be kept so as to be ready for use at a moment's notice in case of emergency. Life-buoys and jackets shall be carefully examined when inspecting the vessel to see that the materials of which they are composed have not become sodden and that the lines attached to them are of sufficient length, serviceable and in good order.

Masts and Sails and Gangboards.

Sec. 19. Section 54 of "The Steam-boat Inspection Act" empowers the Minister of Marine and Fisheries to require steamships above sixty tons registered tonnage, carrying passengers on the sea coasts of the Dominion or on any, or on all the waters of the Dominion, with certain exceptions, to be provided with a mast or masts and sail or sails, suitable for such steam-boat; and to prescribe the dimensions of such mast or masts, and sail or sails respectively.

Sec. 20. Inspectors of hulls when inspecting passenger steam-boats employed on the sea coast, or on the great lakes of the Dominion, are to see that they are fitted with sufficient sail power to enable them to steer in the event of their machinery becoming disabled. All such sails must be examined by the Inspector, who must be assured of their efficiency, as also with that of the standing and running gear at every inspection, and in any case of doubt to apply to the Chairman.

Sec. 21. Inspectors shall see that suitable and safe gangboards are provided with means for securing them safely at both ends.

Sec. 22. In the first inspection of a steam-boat employed on the sea coast or on the great lakes of the Dominion, whether built of iron or wood, the Inspector shall require the compasses to be properly adjusted or verified by a competent person, selected by the owner, whereupon the Inspector shall grant a certificate to the owner to the effect that the compasses of the ship (if an iron ship) are properly adjusted, and a table of errors shall be furnished and handed by the owners to the Inspector before he gives the certificate.

Sec. 23. Inspectors of hulls shall see that the deck pumps, whether worked by hand or steam, are properly placed, sufficient in number, and that provision is made to get at the end of the suction pipes in case of fouling. No deck pump shall be passed which requires charging by hand before taking suction. When such is found to be the case, the Inspector shall insist upon proper provision being made to make the pump efficient at all times. Fire hose should be stretched to their length and thoroughly examined and tried under pressure from the pumps at least once a year, and at any other time the Inspector may deem necessary. The hose should be connected with the pumps for immediate use.

Sec. 24. A spare tiller shall be provided, with relieving tackles, to be kept near the after-steering gear, ready for immediate use on sea-going steamers and steamers on the great lakes. The steering gear shall be inspected and thoroughly examined at least once a year.

Sec. 25. Inspectors of Hulls must be careful to see that every sea-going steamer, subject to the Act, and every steamer employed on the great lakes, is provided with suitable chain cables, anchors and ground tackle, in good condition sufficient for the service in which the vessel is employed, and that the cable be removed from the lockers at least once in a year and cleaned, if necessary, and the pins knocked out of the shackles.

Sec. 26. (a.) Inspectors of Hulls shall keep an office register book for new steamers in which they shall enter particulars of their registration, official number, name, port of registry, dimensions, tonnage, ownership and names of masters; also a general description of build, showing a sketch of the midship section, giving sizes of frames, planking, deck beams, clamps, knees, covering boards and fastenings, as the case may be, sufficient to judge of the vessel and the fitness for the route on which it is to be placed. A description of the upper works on passenger steamers shall also be given stating how the same are secured to the hull, and what provision is made against rolling in a heavy sea.

(b.) The trim of the vessel, light and loaded, shall be shown on the sketch of the midship section.

(c.) The fitness of the boats and other equipments for saving life, whether sufficient for the number of passengers the steamer is allowed to carry, together with the crew on the route she is to be placed shall also be given in the said particulars. A copy of these

particulars in full made out neatly on foolscap paper shall be sent to the Chairman of the Board of Steamboat Inspection and shall be filed for reference in the office for the information of the Department of Marine.

Sec. 27. (a.) Each Inspector of Hulls will also keep an office docking book, in which he shall enter the date of last docking of each steamer inspected by him, with particulars of repairs made upon her; also memoranda of her last inspection, as made by him; the condition in which he then found the hull and equipment; with copy of any correspondence between the owner and master, relating to any repairs, fittings, equipment, or other things which may require proof, in the event of their not having been complied with.

(b.) Inspectors of Hulls shall not consider their duty as finished, in respect to a steam-boat for which they have granted a certificate for a year or any shorter period, but are expected by the Department to have supervision over all steam-boats subject to the Act, within, or coming within their district. Should any infractions of the law on the part of an owner or master of steam-boats come to the knowledge of an Inspector, whereby the safety of life or property is endangered, it will be his duty at once to cause steps to prevent such occurrence by reporting the case to the Department of Marine, with the grounds of the complaint.

Passengers.

Sec. 28. (a.) The number of passengers allowed on passenger steamers may be found by multiplying the length by the breadth of the vessel at the water line, and dividing the product by a factor of safety, according to the class of vessel, thus :—

For ocean steamers the factor shall be.....	10
For ocean coasting steamers.....	10
For steamers navigating in the great lakes.....	9
For lake coasting, harbor, river ferry and excursion steamers.....	6

(b.) No deviation shall be made from this regulation unless with the consent of the Chairman of the Board of Steam-boat Inspection and with the approval of the Minister of Marine and Fisheries.

(c.) In excursion steamers carrying passengers within the hold of the vessel, the limit shall be at the discretion of the Inspector, but in no case shall exceed as many as can find accommodation.

(d.) These factors may be increased to a further limit, if from age or unfitness, the vessel is not considered safe for the carriage of so many passengers.

Sec. 29. The carrying capacity in the number of persons of yawl boats shall be determined as follows, viz. :—

By multiplying the length of the keel by the breadth and by the depth from top of keel to gunwale in feet, and then dividing the product by 10, the quotient will be the number of persons allowed to each boat.

Life-boats and their Equipments.

Sec. 30. (a.) Life-boats shall be built whale-boat fashion; they should have a shear of about $\frac{3}{4}$ inch to a foot, rising equally from amidship to the stem and stern, and to have sufficient strong serviceable air-tight compartments so constructed, fitted and arranged that water can not find its way into them.

(b.) The life-boat must be substantially constructed of galvanized iron of not less than No. 18 wire gauge in thickness.

(c.) Zinc shall not be used in the construction of a life boat or in her air-casings.

(d.) The air-tight compartments must be so distributed as to give the boat good buoyancy and stability. Whether a part of the air-case should be under the thwarts, or whether they should be in the ends and along the sides, will be, so long as an efficient life-boat is obtained, left to the option of the owner.

(e.) Spaces filled with or containing any material are not to be deemed air spaces.

(f.) A square stern boat is not to be passed as a life-boat.

(g.) Life-lines shall be suitably attached to the gunwale of the life-boat.

(h.) The life-boat must be provided with the full complement of oars properly secured; two plugs for each plug hole, attached with lanyards or chains, a bailer, rudder and tiller, also attached to the boat by lanyards; a hatchet, attached with a lanyard, shall be kept in each end of the boat, and a painter and a boathook.

(i.) Means for detaching speedily the life-boat from the lower blocks of the davit tackles must be provided. An ordinary fixed hook in the lower block should not be allowed. The boat's davits must be strong enough and so spaced that the boat can be swung out without unnecessary labour, so that the boat chocks can be expeditiously removed, and the boat will not foul the ship's sides in lowering when the ship has no list; and that the whole of the tackling davits, falls, blocks, eye-bolts, and rings, &c., are of sufficient strength to lower the boat with its full complement on board.

Rate or Duty.

Sec. 31. The following rate or duty shall be paid by the owner or master of every steamboat in Canada, under the provisions of the 46th section of chapter 78 of the Revised Statutes of Canada:

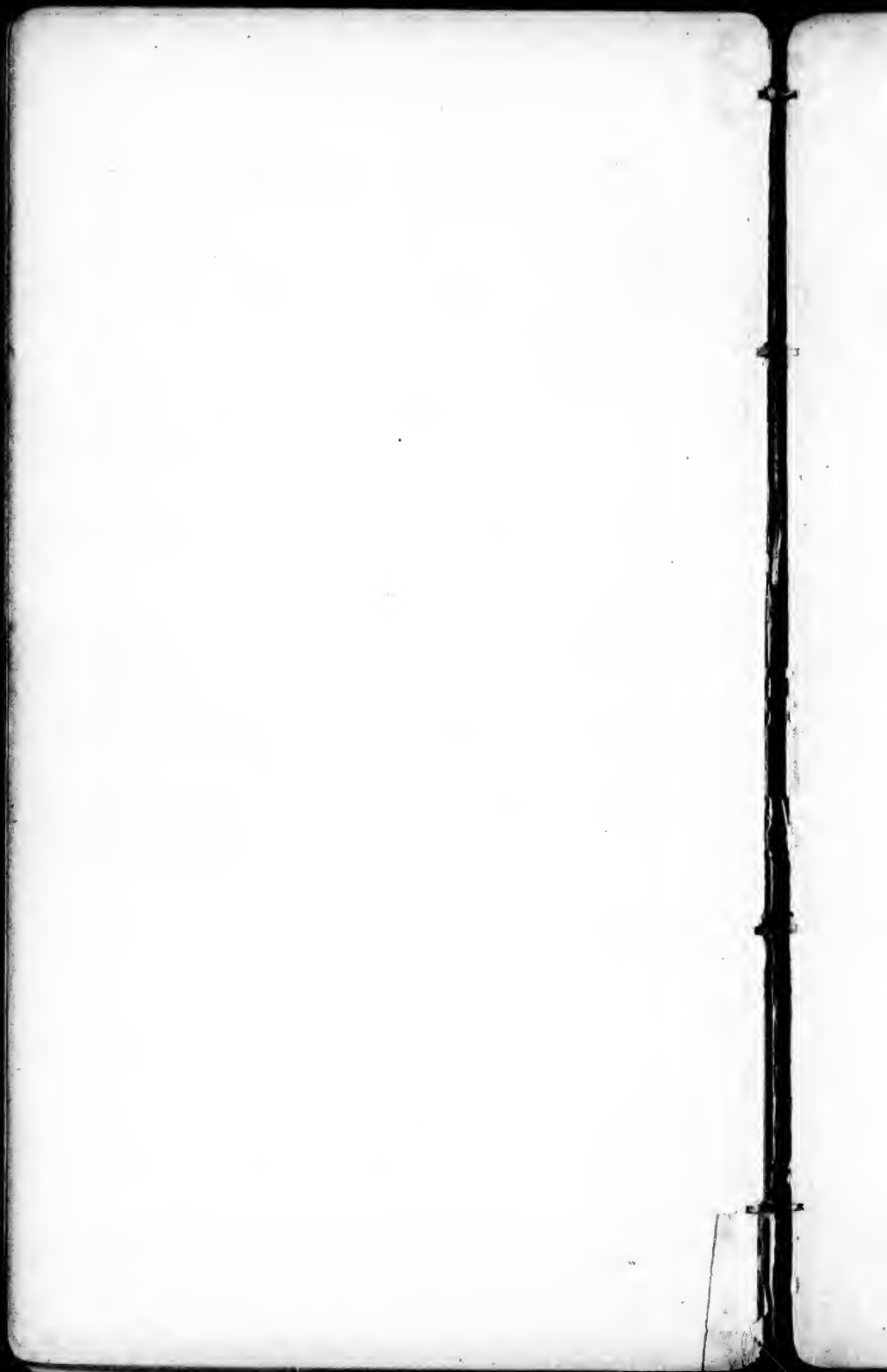
The rate of duty to be paid yearly by owners or masters of steamboats, shall be eight cents for every ton gross, each steamboat measures.*

Revised and approved this 10th day of March, 1891, by the Board.

W. J. MENEILLY, *Chairman*.
THOS. HURBOTTLE,
JAMES JOHNSTON,
O. P. ST. JOHN.

TORONTO, 10th March, 1891.

*NOTE.—This rate was established on the 1st October, 1889.



CONTENTS.

	PAGE.
Part I, Inspection and Testing of Boilers.....	3
Part II, Inspection and Testing of Boilers	17
Part III, Inspection and Testing of Water Tube Boilers	27
Part IV, Inspection of Safety Valves	30
Part V, Duties of Engineers	35
Part VI, Examination of Engineers.....	36
Part VII, Inspection of Hulls	40
Part VII, Rate or Duty.....	45

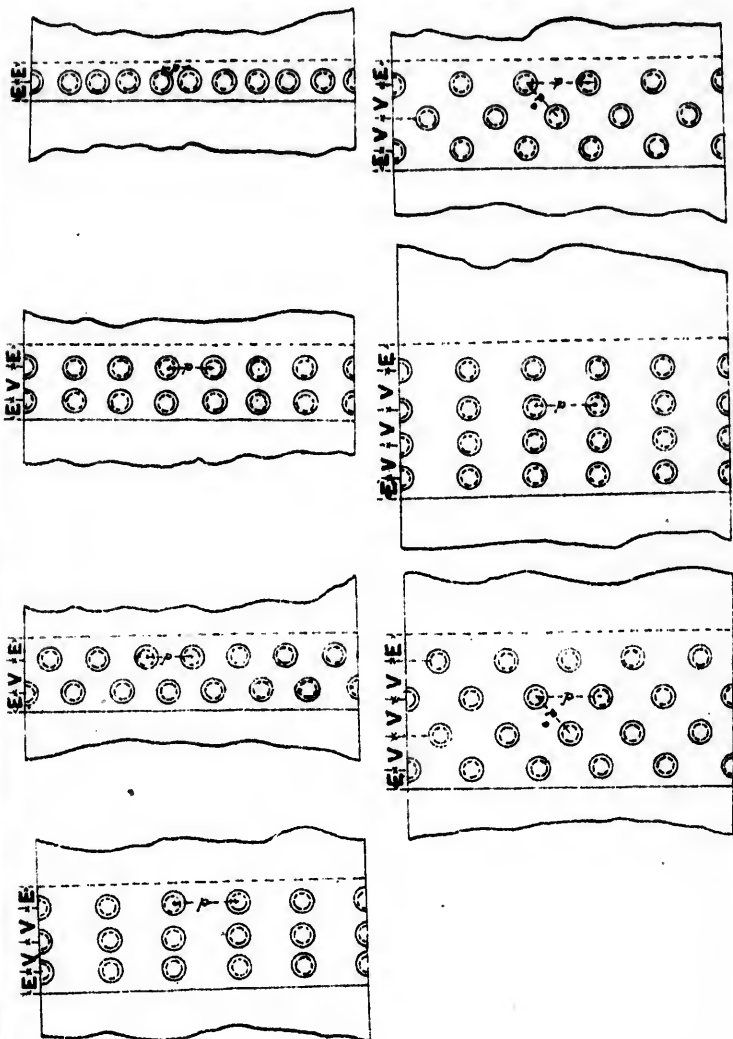
1815
1816

1817
1818

1819
1820

1821
1822

ORDINARY CHAIN AND ZIG-ZAG RIVETED JOINTS

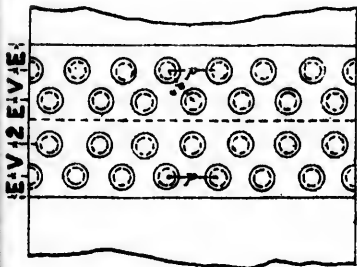
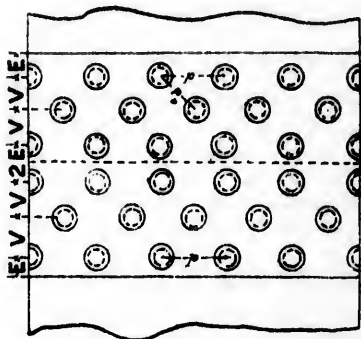
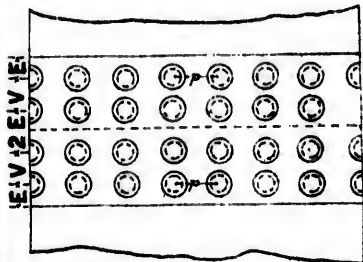
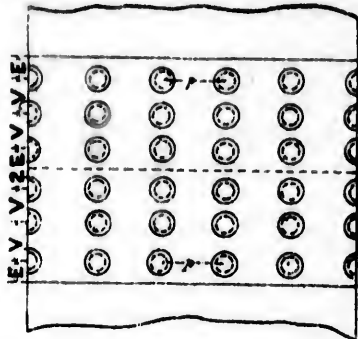
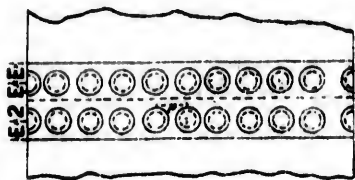


REV 12 EIV 1E1

REV 12 EIV 1E1

REV 12 EIV 1E1

ORDINARY CHAIN AND ZIG-ZAG RIVETED JOINTS - Continued.



E·V + V·E

E·V + V·E + 2E·V + V·E

E·V + V·E + 2E·V + V·E + E

E·V + 2E·V + E

CHAIN AND ZIG-ZAG RIVETED JOINTS IN WHICH EVERY ALTERNATE RIVET IS OMITTED IN THE OUTER ROW, OR IN THE OUTER AND INNER ROWS.

