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Artikel: Characteristic features of welding

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Characteristic Features of Welding.

Charakteristische Merkmale der Schweißung.

Caractéristiques propres à la soudure.

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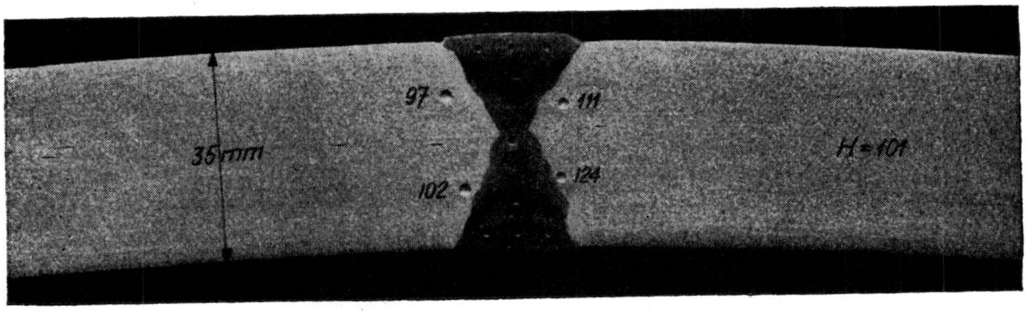
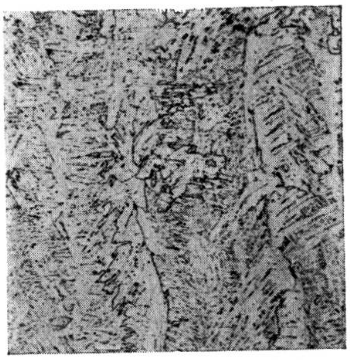
As regards the strength and deformation properties, the quality of the structure of the weld material, including that of the transition zone, is fundamental. Weld metal is in fact a form of steel casting; its structure is heterogeneous and anisotropic — Fig. 1 —, and the theory of constant strain-energy of deformation holds good only if account is taken of the anisotropic condition. In practice, no guarantee can be given that *weld material* is *free from pores* and *slags*. *Shrinkage-cracks* in the outer surfaces and in the interior of the weld material are, as a matter of fact, rare occurrences, but occasionally they may be present — Fig. 2 —. Pores, slag inclusions and cracks must be considered equivalent to a *mechanical imperfection*. *Thermal influences* give rise, on the surface, to the structure known by the name of Widmannstaetten with transcrystallization — Fig. 3 — and in the transition zone to the formation of sorbite, troostite — Fig. 1 — and — in steels containing less than 0.15 % carbon — also martensite — Fig. 4 — which on account of its brittleness promotes the formation of cracks. So far as the material itself is concerned, welding *cannot* therefore be considered equivalent to riveting — Fig. 5 —.

By metallurgical means such as proper choice of the electrodes, correct procedure with pre-heating of the steel when necessary — Fig. 6 —, heat treatment without stress (up to the lower transition-temperature at the most) or annealing (beyond the upper transition-temperature) combined with suitable precautions in design — i. e. reduction of thermal stresses — Fig. 7 —, proper choice of type of connection — Fig. 8 — and shape — Fig. 9 — the mechanical-caracteristics of the welded connection may be made to approximate to those of the riveted connection.

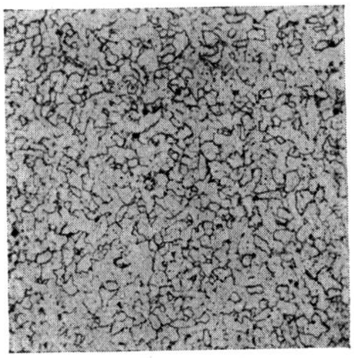
The series of tests and precautions is completed by examination of the welders based on the results of mechanical and deformation tests, either on plates specially welded both in the normal and overhead position or on specimens of suitable shape (round or oval) removed from work carried out in actual practice, combined with X-ray examinations.



$\beta_z \cong 38$ kg/mm² $\sigma_u \cong 16$ kg/mm²

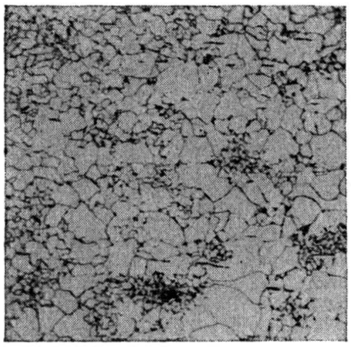


Coarse Widmannstaetten structure in weld metal.



Fine, normalised structure in weld metal.

Thermally altered structure, ferrite and sorbite, transition zone.



Thermally altered structure ferrite and degenerated perlite, transition zone.

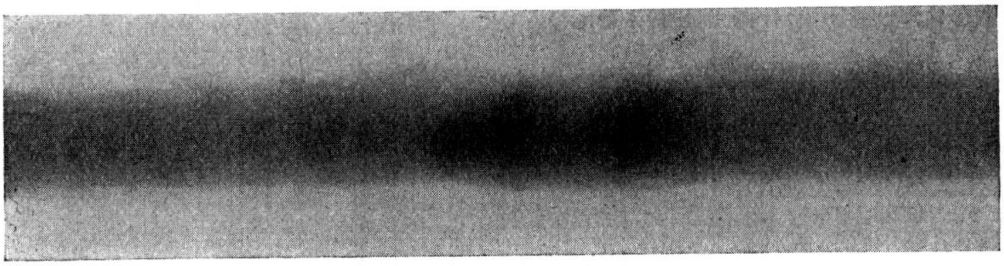
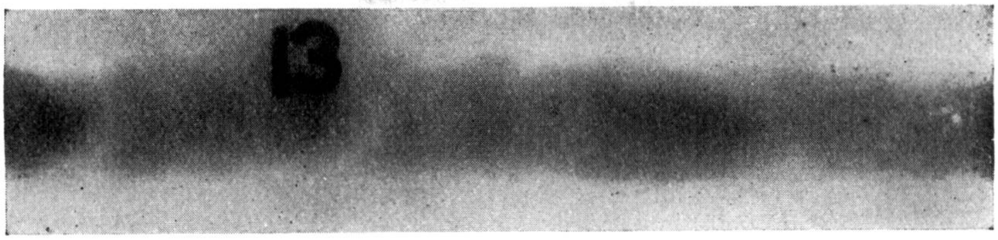
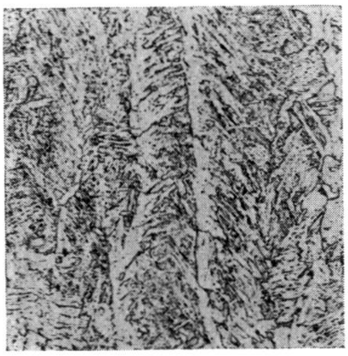


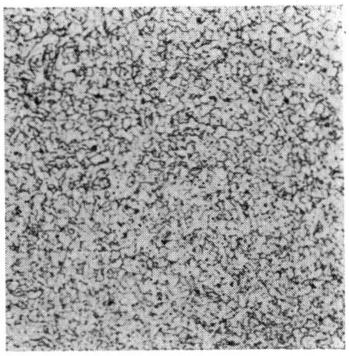
Fig. 1.

Arc weld free from defects, in normal structural steel. Heterogeneity of the weld metal structure.

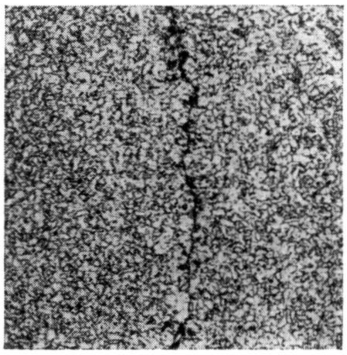




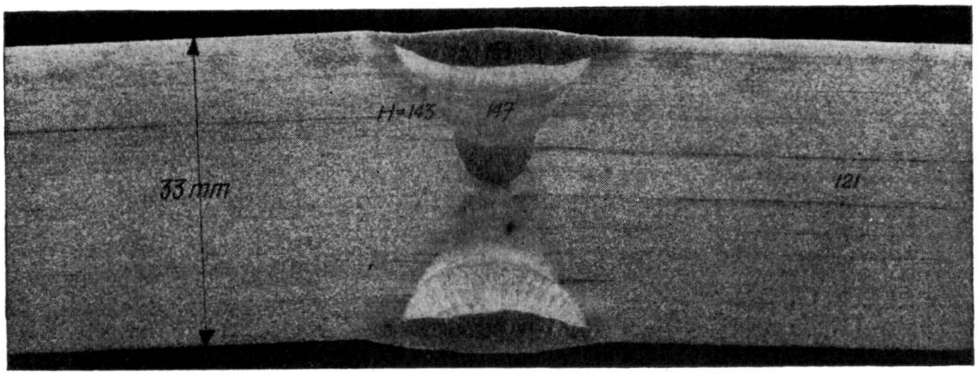
Coarse Widmannstaetten structure, weld metal, last layer.



Fine, normalised change in structure, welt metal.



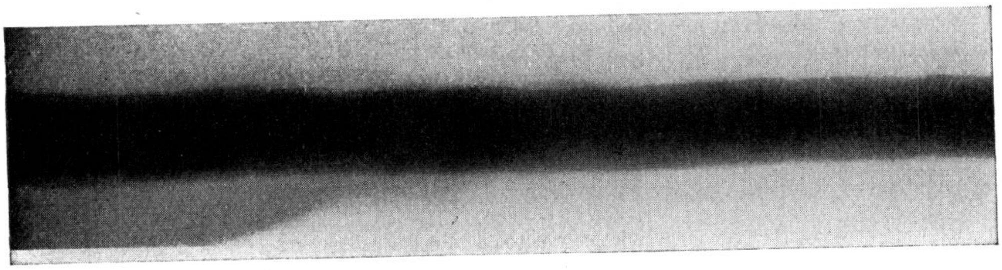
Fine, normalised change in structure with microscopic crack, weld metal.

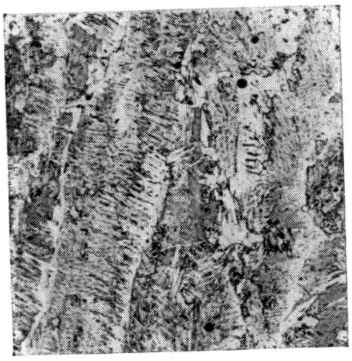


$\beta_z \cong \mathbf{44}\ \mathrm{kg/mm^2}$ $\sigma_u \cong 17\ \mathrm{kg/mm^2}$ $\frac{1}{2}\,\sigma_w \cong 27\ \mathrm{kg/mm^2}$

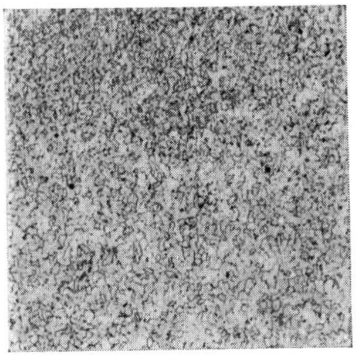
Fig. 2.

Arc weld of superior quality in steel containing 0.25 % C. Microscopic cracks in weld metal.

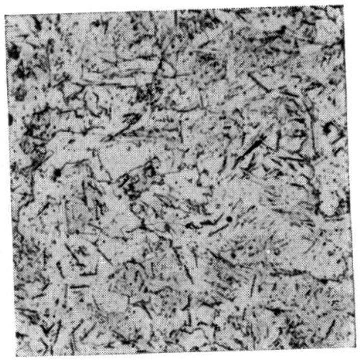




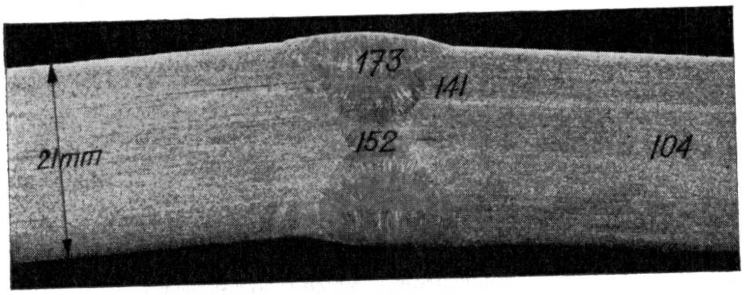
Widmannstaetten structure, weld metal.



Fine alteration in structure, weld metal.



Local enrichment of nitride inclusions, weld metal.

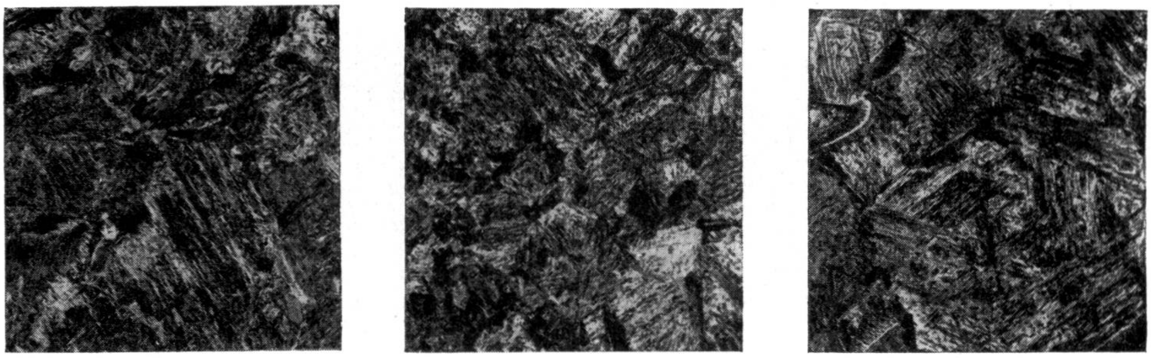


$\beta_z \cong 38$ kg/mm² $\sigma_u \cong 18$ kg/mm² $\frac{1}{2}\sigma_w \cong 26$ kg/mm²

Fig. 3.

Arc weld free from defects, in normal structural steel. Widmanstaetten structure with transcrystallisation.

Siemens-Martin steel with 0.20—0.25 % C.



Temperature: — 10° C.
Martensite with traces of troostite due to quenching effect.

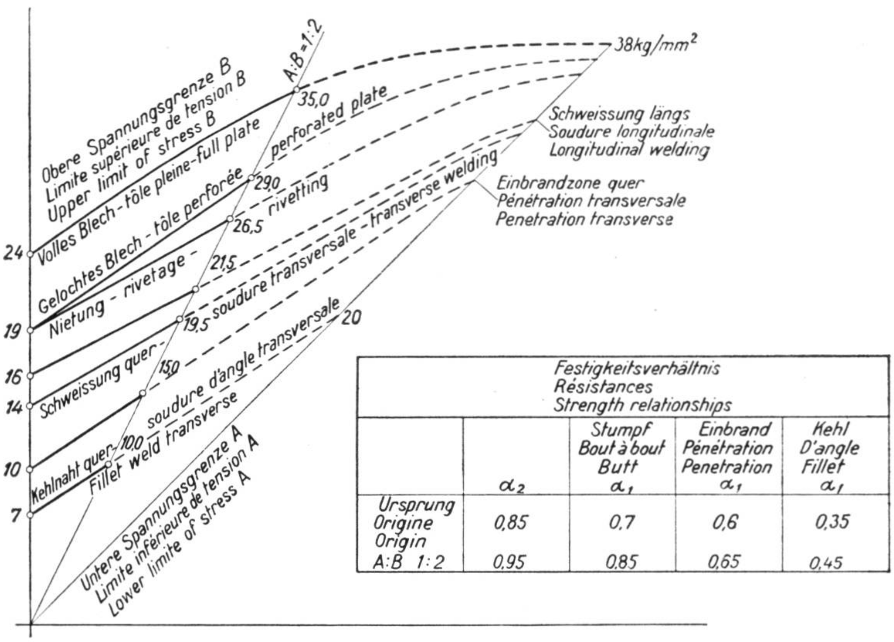
Temperature: 25° C.
Martensite with troostite due to quenching effect.

Temperature: 50° C.
Martensite with little troostite, traces of ferrite.

Fig. 4.

Formation of Martensite in the transition zone immediately at the junction of the weld metal with Siemens-Martin steel plate.

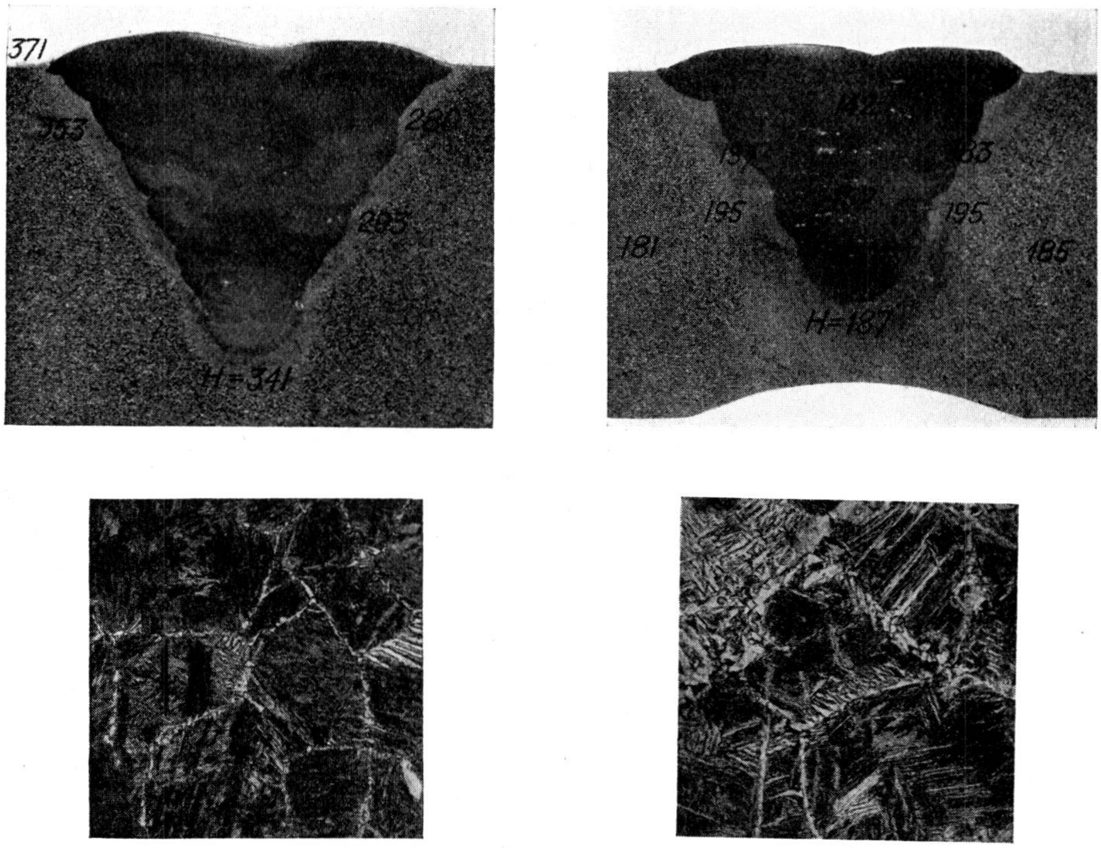
Temperature of the Siemens-Martin steel, when welded, — 10°, + 25° and 50° C.



Festigkeitsverhältnis Résistances Strength relationships				
	α_2	Stumpf Bout à bout Butt α_1	Einbrand Pénétration Penetration α_1	Kehl D'angle Fillet α_1
Ursprung Origine Origin	0,85	0,7	0,6	0,35
A:B 1:2	0,95	0,85	0,65	0,45

Fig. 5.

Tensile fatigue strength in relation to the lower limit of stress.



Not pre-heated, formation of Martensite. | Pre-heated, no formation of Martensite.

Fig. 6.

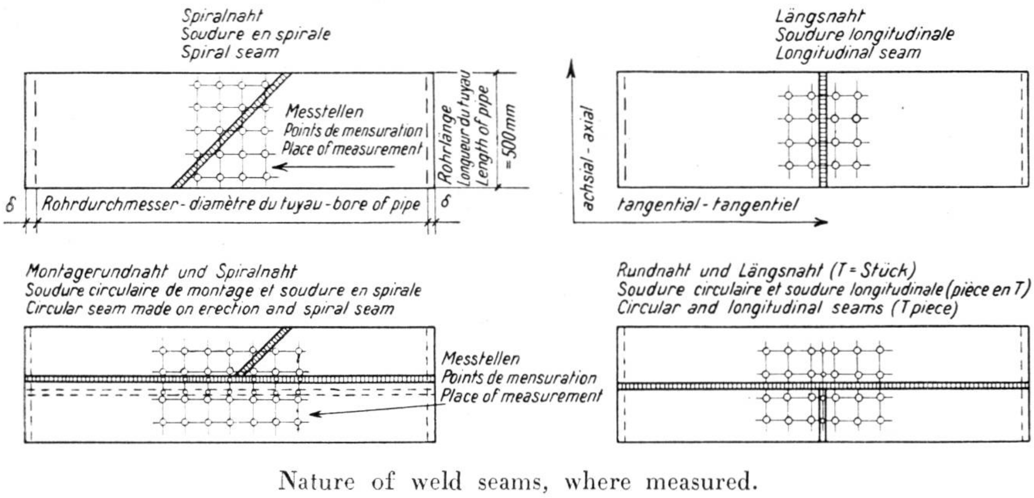
Electrically welded cast steel, carbon content 0.28 %.

Welding without pre-heating:

High hardness number in the transition zone, formation of Martensite.

Welding with pre-heating:

Normal hardness number, no formation of Martensite.



Nature of weld seams, where measured.

Fig. 7a.

Internal stresses of weld seams, annealed and not annealed.

Maximum values of internal stresses as measured.

annealed or not	Nature of weld seams where measured	Reduced internal tensile stresses in kg/cm²	
		axial	tangential
annealed	Longitudinal X-seam	+ 1010	+ 1060
not annealed	Longitudinal X-seam	+ 1620	+ 2460
annealed	Spiral X-seam	+ 280 + 447	+ 727 + 336
not annealed	Circular and longitudinal U-seams	+ 2070	+ 2070

Fig. 7 b.

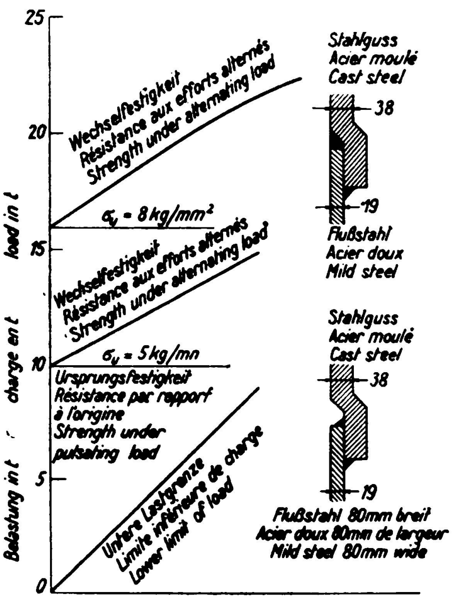
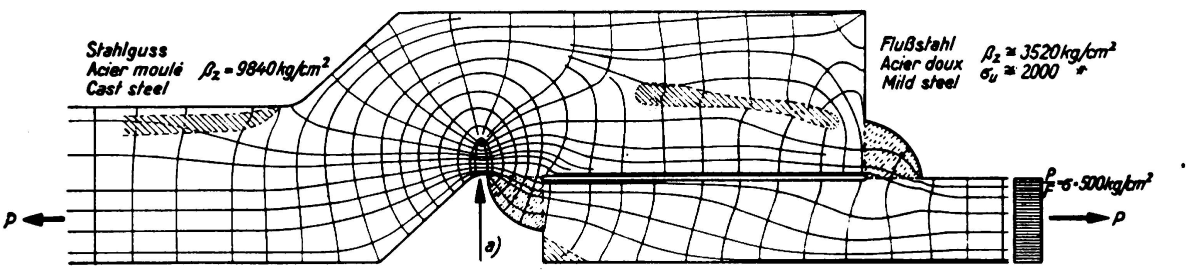


Fig. 8 a.

Increased resistance to alternating stress through suitable weld connections between cast steel and mild steel.



a) Navier-Hooke stresses, by calculation $\frac{P}{F} + \frac{M}{W}$: $\sigma_{max} = 2{,}8\,\sigma = 1400$ kg/cm².

Resistance of the connection to pulsating stress: $\sigma_u \cong 500$ kg/cm².

Concentration of stress at base of notch as determined optically: $\sigma_{max} = 5\,\sigma = 2500$ kg/cm².

Fig. 8 b.

Stress conditions at base of notch.

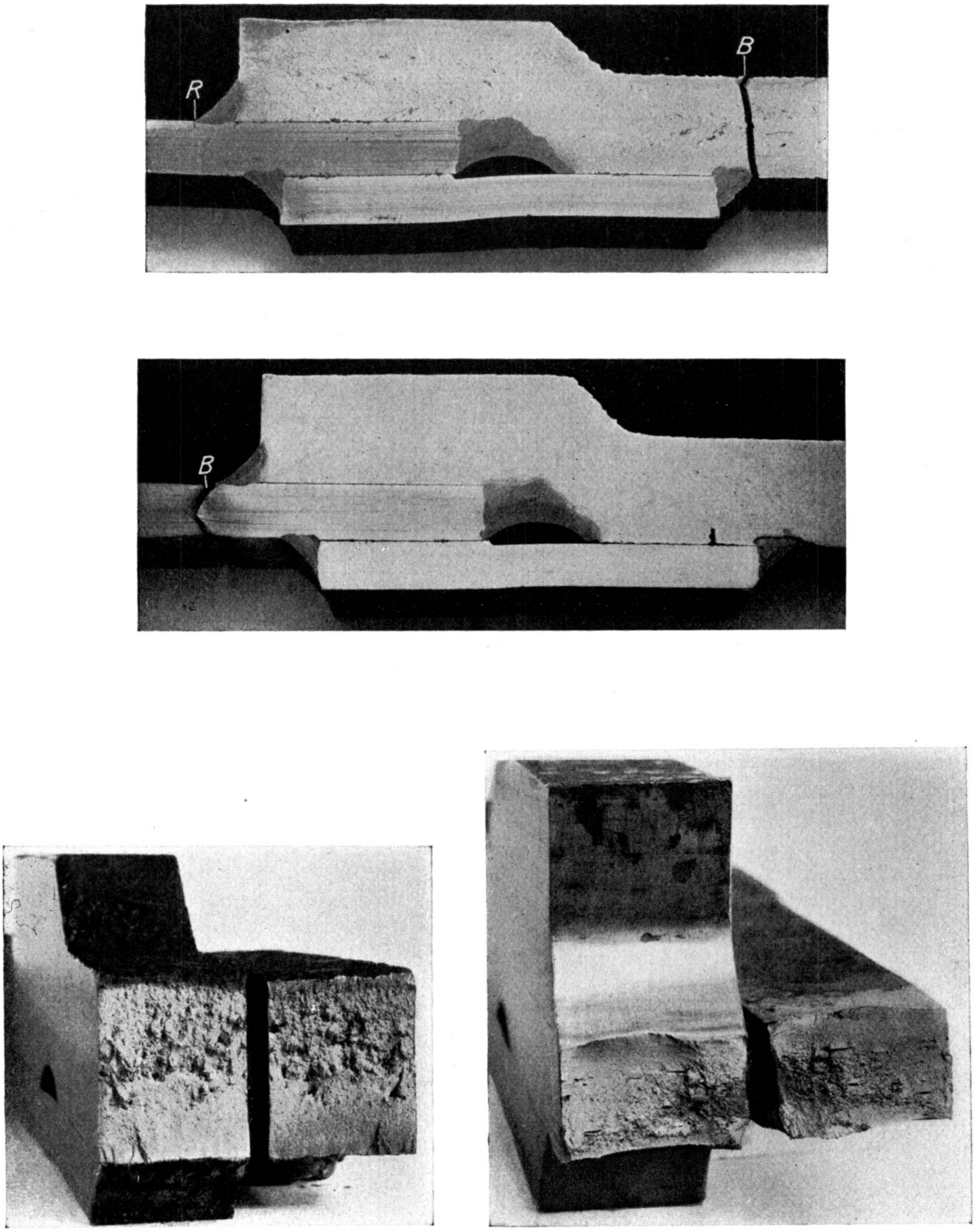


Fig. 9.

Welded connections between cast steel and mild steel.
Increased resistance to pulsating stress by grinding the weld seams.